

AMDAHL AS A VIABLE ALTERNATIVE

INPUT

ABOUT INPUT

INPUT provides planning information, analysis, and recommendations to companies in the information processing industries. Through market research, technology forecasting, and competitive analysis, INPUT supports client management in making informed decisions. Continuing services are provided to users and vendors of computers, communications, and office products and services.

The company
clients on imp
then develop
receive repor
continuous cor

INPUT

Amdahl As a Viable Aletnative To
IBMTM Plug Compatible Main-

Professional s
processing in
marketing, or
complex busir

Formed in 19
include over 1

h. Working closely with
rpret the research data,
t clients' needs. Clients
analyses are based, and

ence in the information
positions in operations,
ply practical solutions to

consulting firm. Clients
dvanced companies.

UNITED S

2180 Sand
Menlo Par
(415) 854-

15 Bond S
Great Ne
(516) 482-

EUROPE

INPUT Europe
500 Chesham House
150 Regent Street
London, W1R 5FA
England
London 439-6288
Telex 261426

Infocom Australia
Highland Centre, 7-9 Merriwa Street
P.O. Box 110, Gordon N.S.W. 2072
(02) 498-8199

vice Company, Ltd.
No. 12-7 Kita Aoyama
Ku

IMPACT REPORT

INPUT LIBRARY

AMDAHL AS A VIABLE ALTERNATIVE TO IBM

**PLUG COMPATIBLE MAINFRAMES:
SURVIVAL OR PROSPERITY**

INPUT LIBRARY



Digitized by the Internet Archive
in 2015

<https://archive.org/details/impactreportamdaunse>

AMDAHL AS A VIABLE ALTERNATIVE TO IBM

PLUG COMPATIBLE MAINFRAMES:

SURVIVAL OR PROSPERITY

TABLE OF CONTENTS

	<u>Page</u>
INTRODUCTION	1
ADDENDUM	2
I MANAGEMENT ACTION SUMMARY	4
A. SHORT-TERM RESPONSES (NEXT 6-12 MONTHS)	4
B. LONGER TERM RESPONSES (NEXT 12-24 MONTHS)	5
C. IMPLICATIONS FOR COMPUTER SERVICES COMPANIES	6
II AMDAHL'S OBJECTIVE: TWICE THE PERFORMANCE AT THE SAME PRICE	11
A. MEASURING THE WORKLOAD	11
B. BENCHMARK RESULTS CONSISTENT	13
C. COMPARING INDIVIDUAL INSTRUCTIONS	13
D. AMDAHL MEETS PRICE PERFORMANCE OBJECTIVES	19
IIIA SURVEY RESULTS OF USERS WHO SELECTED THE AMDAHL SYSTEM . .	20
A. BETTER PRICE PERFORMANCE AND FASTER DELIVERIES	20
B. EVERYBODY NEEDS . . . MORE MEMORY	20
C. THE LONG AND CAREFUL SELECTION PROCESS	21
D. FEW AMDAHL BUYERS ARE CONCERNED OVER FUTURE IBM DEVELOPMENTS	23
E. BENCHMARKING, A DIMINISHING ISSUE	24
F. AMDAHL 470V/6 EASY TO INSTALL AND PERFORMING TO EXPECTATIONS	25
G. IBM FOUGHT HARD TO KEEP THE ACCOUNTS	27
H. AMDAHL MARKETING HAS THE PERSONAL TOUCH	28

	<u>Page</u>
I. AMDAHL INSTALLATIONS PENETRATED BY PCM PERIPHERAL VENDORS	28
J. IBM STILL DOMINANT IN TAPE DRIVES	29
K. PRINTERS — NO PLUG COMPATIBLE PENETRATION	29
L. PROLIFERATION OF TERMINALS LEADS TO DISTRIBUTED PROCESSING	29
M. TWO IS COMPANY; THREE IS A CROWD	31
N. AMDAHL SYSTEMS INTERCONNECTING AND GROWING	31
O. NO MORE CHANNELS PLEASE	31
P. RED CARPET FOR PLUG COMPATIBLE VENDORS	32
 IIIB SURVEY RESULTS OF USERS WHO DID NOT SELECT AMDAHL	 35
A. IBM SELECTION RECOMMENDED BY STUDY TEAM	37
B. HALF THE USERS BOUGHT THE EQUIPMENT	37
C. BENCHMARKS SHOW AMDAHL AHEAD	38
D. IBM INCREASES SERVICE WHEN COMPETITIVE MACHINES ARE CONSIDERED	38
E. AMDAHL MARKETING PERSONNEL IMPROVING	40
F. AMDAHL WILL BE CONSIDERED IN FUTURE BUYS	40
G. IBM DOMINATES PERIPHERALS IN NON-AMDAHL INSTALLATIONS	42
1. DISK DRIVES TAPES AND PRINTERS	42
2. RJE STATIONS AND TERMINALS PROLIFERATING	42
3. VARIOUS OPERATING SYSTEMS UTILIZED	45
4. INCREASING NETWORK INTERCONNECTION	45
H. USERS PLANNING TO EXPAND CAPACITY	45
 IV IBM STRATEGIES/AMDAHL COUNTERSTRATEGIES	 47
A. ALL IN THE FAMILY	47
B. THE EXTENDED FAMILY	48
C. WILL IBM INTRODUCE "FIGHTING MACHINES"?	49
D. 'CARROT AND STICK' STRATEGY MOTIVATES THE USER TO UPGRADE	51
E. PLUG COMPATIBLE MANUFACTURERS INTERJECT A SOUR NOTE	54
F. POWER TO THE DISTRIBUTED PROCESSOR	54
G. REMEMBER: MEMORY PRICES WILL DECLINE	55
H. INTEGRATING DATA CHANNELS INTO THE MAINFRAME	57
I. MULTIPLE MAINFRAMES AND SPECIAL FUNCTION PROCESSORS LEAD TO DISTRIBUTED PROCESSING	58
J. IBM MAY ACCELERATE THE INTRODUCTION OF A 168 UPGRADE	59
K. IBM MAINTAINS SOME CONTROL OVER MOST AMDAHL USERS	60
L. WHAT WILL IBM REALLY DO?	61
M. HOW AMDAHL CAN REDUCE ITS VULNERABILITY	62

	<u>Page</u>
V GROWING MARKET FOR LARGE MAINFRAMES	66
A. TWENTY PERCENT PENETRATION FOR PLUG COMPATIBLE MAINFRAMES	66
B. PENT-UP DEMAND FOR LARGE SYSTEMS	67
VI OPPORTUNITIES FOR THIRD PARTY VENDORS	74
A. PERIPHERALS OPENED THE DOOR	74
B. AMDAHL PERIPHERALS — THE FUJITSU CONNECTION	77
C. LIMITED OPPORTUNITY FOR THIRD PARTY MAINTENANCE	78
D. INCREASED OPPORTUNITIES FOR SOFTWARE VENDORS	78
E. MORE LARGE MAINFRAMES AVAILABLE TO USED COMPUTER BROKERS	80
APPENDIX I PLUG COMPATIBLE MANUFACTURERS	84
APPENDIX II INTERNAL PERFORMANCE 470V/6 VS. 168 and 158 . .	89
APPENDIX III COMPANY HIGHLIGHT	93
APPENDIX IV AMDAHL QUESTIONNAIRE	96

LIST OF EXHIBITS

		<u>Page</u>
I-1	PRICE PERFORMANCE COMPARISON OF PRESENT AND PROJECTED SYSTEMS	7
2	POSSIBLE IBM PRICE PERFORMANCE IMPROVEMENT STRATEGIES FOR CURRENT SYSTEMS (135=1)	8
3	COMPARISON OF THE PRICE/PERFORMANCE OF THE PRESENT AND PROJECTED 370 MODELS IN TERMS OF THE 370/135	9
II-1	REPORTED BENCHMARK RESULTS (AMDAHL X 168)	12
2	SPECIFIC BENCHMARK RESULTS (AMDAHL X 168-1)	14
3	SPECIFIC BENCHMARK RESULTS (AMDAHL X 158-1)	15
4	FREQUENCY DISTRIBUTION OF NUMBER OF INSTRUCTIONS ON 470V/6 AND THEIR SPEED IN RELATION TO THE 168 (WHERE 1.0 = 168)	16
5	FREQUENCY DISTRIBUTION OF NUMBER OF INSTRUCTIONS ON 470V/6 AND THEIR SPEED RELATIVE TO THE 158 (WHERE 1 = 158)	18
IIIA-1	MAINFRAMES REPLACED BY AMDAHL	22
2	ONE AMDAHL USER'S BENCHMARK RESULTS	26
3	RANDOM ACCESS MEMORY CONFIGURATION OF AMDAHL INSTALLATIONS	30
4	INVENTORY OF PERIPHERAL STORAGE EQUIPMENT INSTALLED AT SITES OF RESPONDENTS WHO SELECTED THE AMDAHL SYSTEM	33
5	SUMMARY OF INSTALLED PERIPHERALS BASED ON 10 RESPONDENTS	34
IIIB-1	COMPARISON OF USER EQUIPMENT CONFIGURATION	36
2	BENCHMARKS	39
3	DISK DRIVES INSTALLED ON SURVEYED SYSTEMS	43
4	INVENTORY OF DISK STORAGE DEVICES AT SURVEYED INSTALLATIONS WHERE AMDAHL WAS NOT SELECTED	44
IV-1	IBM'S MAIN MEMORY PRICE CHANGES FOR SYSTEM 370	56
2	TIME FRAME OF POTENTIAL IBM RESPONSES	63
V-1	SYSTEM DISTRIBUTION YEAR-END 1975	69
2	INSTALLED BASE (UNITS) IBM LARGE COMPUTERS YEAR-END 1975-1980	70

	<u>Page</u>
V-3 AMDAHL REVENUE FORECAST	71
4 AMDAHL CUMULATIVE 1980 REVENUES	72
5 AMDAHL SHIPMENT FORECAST	73
 VI-1 PERIPHERALS MARKET POTENTIAL	 76
2 THIRD PARTY MAINTENANCE	79
3 REPLACED COMPUTERS	81
4 USED COMPUTER REVENUES	82

INTRODUCTION

INPUT

INTRODUCTION

- This report is produced by INPUT as part of the Market Analysis Service.
- Research carried out for this report included interviews with:
 - 10 companies which are present users of Amdahl equipment
 - 9 companies which considered but rejected acquisition of Amdahl computers."
- Interviews were carried out in October 1976 by telephone.
- The benchmarks quoted in this study were prepared by a consultant affiliated with INPUT.
- Research also included visits to Amdahl and discussions with their management, technical, and marketing personnel.
- Draft copies of this report were submitted to IBM and Amdahl. Extensive comments were obtained from Amdahl; no comments were obtained from IBM.
- Inquiries and comments on the information presented in the report are requested from clients.

ADDENDUM

- As this report was going to press on October 26, 1976, IBM announced the 370/158 AP.
- The Attached Processor is priced as follows:

MODEL #	SALE PRICE	MAC	TAP
3052 AP	\$380,000	\$12,700	\$11,500
Remote Console	20,800	545	496
Upgrade Feature	49,000	1,600	1,500
TOTAL	\$449,800	\$14,845	\$13,496

- The comparison between the 158-3 and the 158 Attached Processor shows that the price performance improves at the high end.

MODEL #	SALE PRICE	MAC	TAP
158-3 (512 K)	\$1,973	\$42,280	\$38,440
158-3 (6 MB)	2,960	75,940	69,050
158 AP (512 K)	2,423	57,125	52,936
158 AP (6 MB)	3,413	90,785	82,540

- IBM indicated that the internal performance improvement ranges from 1.5 to 1.8.

- If a median of instruction execution speeds is taken, the price/performance improvement of the 158 AP over the 158-3 is 1.5. Thus the 158 AP effectively fills the performance "hole" described elsewhere in this report.

I. MANAGEMENT ACTION SUMMARY

INPUT

I MANAGEMENT ACTION SUMMARY

- IBM will be forced to react to the challenge of the plug compatible mainframes during the late 1976-early 1977 time frame.
- IBM, however, will not introduce a fighting machine but will respond in accordance with its long-term goal of preserving its growth and revenue objectives rather than destroying competition.
- The IBM response will be in two steps, both aimed at improving the price performance of the 158 and 168: the first step will be to upgrade the 158 and will occur by the end of 1976, followed by the upgrade of the 168. Both of these upgrades will be short-term responses to competitive pressures. The long-term (12-24 months) response will be to introduce a new generation of systems replacing the 158 and 168 mainframes.

A. SHORT TERM RESPONSES (NEXT 6-12 MONTHS)

- Lower the lease and purchase price of MOSFET memories.
- Integrate the data channels into the mainframe and reduce prices by 20%.
- Increase the size of the high speed buffer to increase throughput.
- Introduce a 158 APS with a 1.4 to 1.6 price performance improvement.

- Introduce a 158R* and 168R* and a 168 APS-2.
- Introduce a 2305 replacement to speed up the virtual memory operating system.

B. LONGER TERM RESPONSES (NEXT 12-24 MONTHS)

- Modify the architecture of the 158 and 168 by converting the mainframes into a functional multiprocessor containing an instruction processor, a service processor, a control processor, and one or more I/O processors, similar to the 115 and 125 design.
- Change channel interfaces and introduce security hardware codes between the I/O processors and the instruction processor. This would force competitive processors to emulate in software the IBM hardware features causing them to slow down.
- Put some of the OS software into hardware to make compatibility more difficult.
- Utilize the relocatable control storage and ROMs to put into hardware a variety of operating system kernels, applications, and language processors to increase throughput and reduce the operating system overhead.
- Increase number of instructions to facilitate VM.
- Replace its present components with higher density chips (16K memory chips are currently in production while 32K and 64K chips are in the prototype stage) to reduce component count, increase reliability, reduce costs and power requirement.
- Utilize a new memory technology such as bubble or CCD to

reduce memory costs.

- Some of the above responses would be self-impacting; others may expose IBM to suits. IBM will announce those responses which, when simulated on its in-house system, will yield the optimum impact on competitors without significantly reducing revenues or increasing legal exposure. This judicious combination will also provide a solid base from which to launch the next generation of mainframes.
- The user who buys the 470V/6 is not exposing himself to a major risk if his payoff period is four years or less because the likely price performance of the short-term upgrades of the 158 and 168 systems will not provide significant price/performance advantages as shown in Exhibit I-1.
- Amdahl management is aware of IBM's options and is ready with its own countermeasures. The net effect may be to slow down Amdahl's growth and to gradually change Amdahl from an IBM plug compatible mainframe manufacturer to a supplier of a variety of functional mainframes.
- Exhibit I-2 shows the competitive situation facing IBM.
- As shown in Exhibit I-3, the 158 violates the current price/performance curve for System 370. It is in a 'hole' and IBM has to upgrade it almost immediately. Indeed, announcements of the upgrade have already been delayed; INPUT considers this due to the Intel/National Semiconductor developments.

C. IMPLICATIONS FOR COMPUTER SERVICES COMPANIES

- Based on the interviews with the computer services companies who purchased the 470V/6, the Amdahl alternative is worth analyzing on the

EXHIBIT I-1

PRICE PERFORMANCE COMPARISON
OF PRESENT AND PROJECTED SYSTEMS

IBM SYSTEMS	1977	1978	1979	1980
168-1	1	1	1	1
168-3	1.4	1.4	1.4	1.4
470V/6	1.9	1.9	1.9	1.9
168R (E)*		1.7	1.7	1.7
168 APS-2(E)			1.85	1.85
470V/12 (E)			2.4	2.4

* = INPUT Estimate

EXHIBIT I-2

POSSIBLE IBM PRICE PERFORMANCE IMPROVEMENT STRATEGIES FOR CURRENT SYSTEMS (135=1)

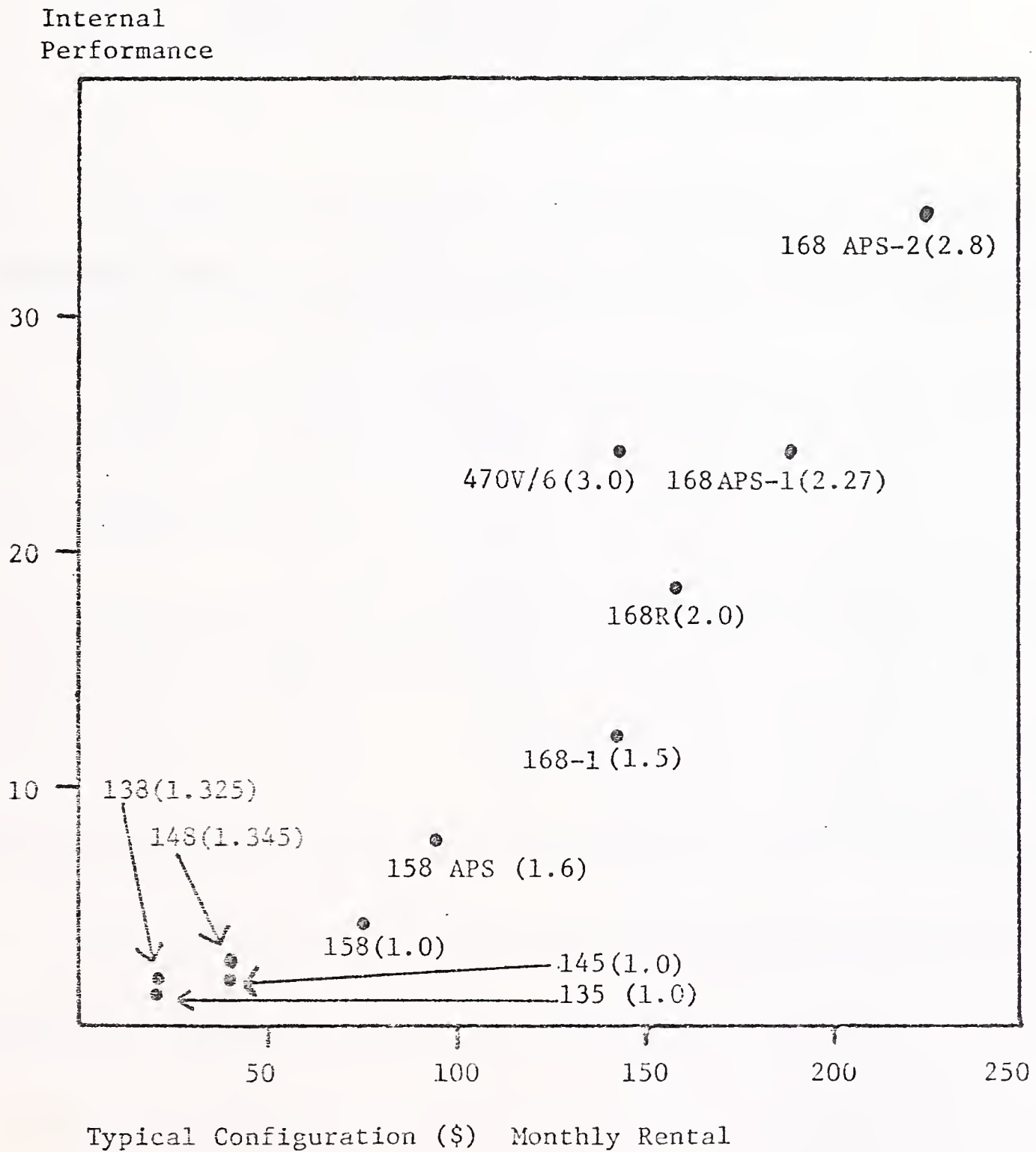


EXHIBIT I-3

COMPARISON OF THE PRICE/PERFORMANCE
OF THE PRESENT AND PROJECTED 370 MODELS
IN TERMS OF THE 370/135

MODEL NUMBER	INTERNAL SPEED	PRICE/PERFORMANCE [*]
135	1.0	1.0
138	1.3	1.3
145	1.6	0.9
148	2.2	1.3
158	4.2	1.0
** 158AP	7.5	1.6
168-1	12.1	1.5
** 168R	18.0	2.0
168-APS-1	22.9	2.3
470V/6	24.0	3.0
** 168-APS-2	34.2	2.8

* Price/performance of System 370 Model 135 taken as the norm.

** IBM systems expected to be announced within the next 6 to 12 months.

basis of the following factors:

- 1.9 increase in price performance.
- Quick delivery.
- Minimal conversion cost for 370/168 users.
- The residual value is likely to remain high.
- The uptime is as good as the 370/168.

• The caveats are:

- The potential buyer should run his programs on a comparable system to insure that all his software runs smoothly and that customer response time is equal or better.
- IBM may introduce a "more compatible" system in the 1978-1979 time frame which would make future IBM programs incompatible with the Amdahl machine.

• The less dependent a user is on IBM software, the smaller his risk in choosing an Amdahl system.

II. AMDAHL'S OBJECTIVE: TWICE THE PERFORMANCE AT THE SAME PRICE

INPUT

II AMDAHL'S OBJECTIVE: TWICE THE PERFORMANCE AT THE SAME PRICE

- The general performance objectives of the Amdahl 470V/6 were to provide approximately twice the price/performance of the IBM 370/168 Model 1 at approximately the same cost. Since performance of large scale systems in complex and diverse operating environments is difficult to define - much less measure - several performance measurement methods will be presented.

A. MEASURING THE WORKLOAD

- For any individual user the best measure of performance is his work load. Five users who currently have Amdahl 470V/6s installed reported the results of eight benchmarks. The range of reported results was from 1.1 to 2.3 times the 370/168. Seven users who rejected Amdahl for various reasons also reported results with a range of 1.3 to 2.0. In both cases, these extremes were contained in a single series of benchmarks reported as a range. If each of the 15 ranges is averaged and reported as a single benchmark, the results are more consistent, as can be seen in Exhibit II-1.
- The results reported by those who bought and those who rejected Amdahl are quite close. The overall results show that 80% of the

EXHIBIT II-1

REPORTED BENCHMARK RESULTS (AMDAHL X 168)

	AMDAHL USERS	AMDAHL REJECTED	OVERALL
	1.90	1.65	
	1.62	1.45	
	1.70	1.73	
	1.60	1.45	
	1.51	1.25	
	1.70	1.75	
	1.50	1.60	
	1.30		
MEAN	1.60	1.55	1.58
STANDARD DEVIATION	.18	.18	.17

reported results fall within the range of 1.41 to 1.75 (one standard deviation on either side of the mean).

B. BENCHMARK RESULTS CONSISTENT

- INPUT contracted with an independent consultant to obtain the results of a specific series of benchmark tests. The results of these benchmarks were not included in Exhibit II-1 but are comparable to those results (see Exhibit II-2).
- The total for the entire series of benchmarks was heavily influenced by the applications which were run since they consumed more overall time than the specific tests which were made. The overall results are somewhat on the high side compared to those reported in our interviews, but that is probably due to the nature of the applications selected which used a substantial amount of decimal arithmetic.
- The same benchmarks were also run on the 370/158 with the results contained in Exhibit II-3.
- The overall result is heavily influenced by the applications systems, and the substantial improvement in floating point does not get weighted heavily.
- Of course, performance can also be measured by raw speed. Attached to this report is a listing which compares Amdahl to both the 168 and 158 on an instruction by instruction basis. (See Appendix II)

C. COMPARING INDIVIDUAL INSTRUCTIONS

- Exhibit II-4 is the frequency distribution of the results of Amdahl

EXHIBIT II-2

SPECIFIC BENCHMARK RESULTS (AMDAHL X 168-1)

1 - Major Application (Assembly Language)	1.69
2 - IBM Sort (Included in 1)	1.18
3 - IBM Sort (Also Included in 1)	1.47
4 - Application (Cobol)	1.81
5 - Application (Fortran)	1.65
6 - Link Edit	1.00
7 - Floating Point (Tape Output Interspersed)	1.09-1.27
8 - Floating Point (Disk Output Interspersed)	1.17-1.23
9 - Floating Point (No I/O)	1.32
10 - Integer	1.36
11 - Packed Decimal	1.83
12 - Internal Sort	1.49
13 - Tape Writes	1.03
14 - Disk Writes	1.06
15 - Total for Series (1-14)	1.70

EXHIBIT II-3

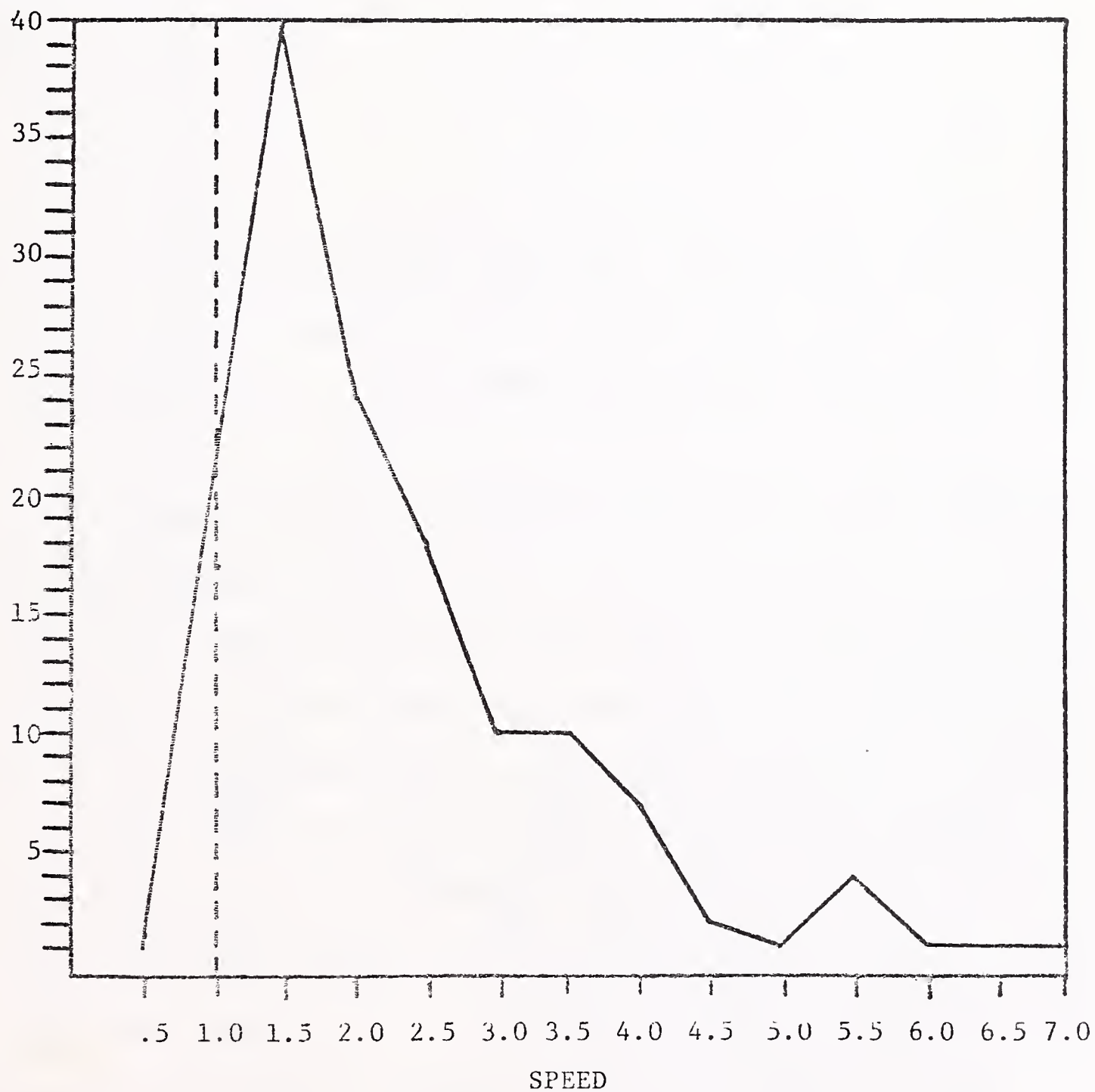
SPECIFIC BENCHMARK RESULTS (AMDAHL X 158-1)

1 - Major Application (Assembly Language)	4.41
2 - IBM Sort (Included in 1)	3.08
3 - IBM Sort (Also Included in 1)	3.18
4 - Application (Cobol)	4.98
5 - Application (Fortran)	5.26
6 - Link Edit	3.40
7 - Floating Point (Tape Output Interspersed)	5.51-7.65
8 - Floating Point (Disk Output Interspersed)	5.96-7.07
9 - Floating Point (No I/O)	7.84
10 - Integer	4.60
11 - Packed Decimal	5.18
12 - Internal Sort	4.47
13 - Tape Writes	3.08
14 - Disk Writes	3.47
15 - Total for Series (1-14)	4.95

EXHIBIT II-4

FREQUENCY DISTRIBUTION OF NUMBER OF INSTRUCTIONS ON
470V/6 AND THEIR SPEED IN RELATION TO THE 168 (WHERE 1.0 = 168)

INSTRUCTIONS



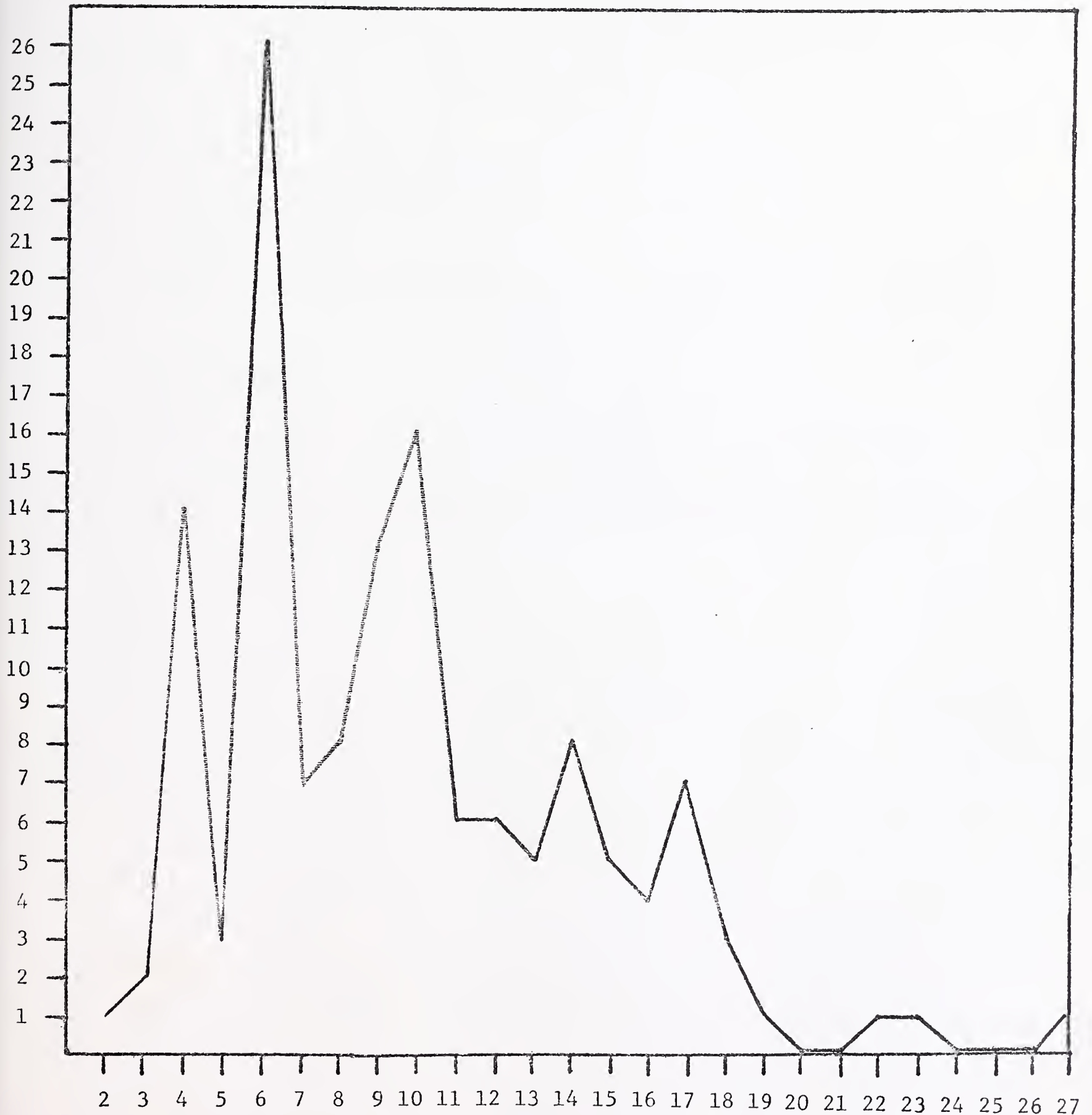
compared to the 168 (one instruction not shown on the plot ((Test and Set)) is over 15 times faster on Amdahl). As can be seen, eighteen instructions are slower on Amdahl than on the 168. The most significant one is Execute where the 168 is more than two times as fast as Amdahl. Since the early tests, Amdahl has released a no cost Engineering Change (EC) which increases the relative performance of the 470V/6 Execute instruction to twice that of the IBM 370/168. Sixteen of the slower instructions are in the double precision floating point instruction set and the other is Shift Left Double. However, most Amdahl instructions are between 1.5 and 2.5 times faster than the 168. The higher speed instructions are mostly storage to storage instructions. The mean performance gain when all instructions are compared to the 470V/6 is 1.79. (see Appendix II).

- Exhibit II-5 plots the same information for Amdahl compared to the 158. There is less consistency in the relative speeds of various types of instructions than there is with the 168. However, Amdahl compares favorably on the floating point instruction set (just as the 168 does compared to the 158). The mean performance gain for all instructions is 7.00 (see Appendix

- Therefore, the benchmark performance improvement of the 470 over the 168 is close to the internal instruction set performance improvement (1.70 benchmark compared to 1.79 internal), whereas the 158 benchmark does not reflect the internal performance (4.95 benchmark compared to 7.00 internal), because of the high proportion of the floating point instructions contained in the total number of instructions measured.

EXHIBIT II-5

FREQUENCY DISTRIBUTION OF NUMBER OF INSTRUCTIONS ON
470V/6 AND THEIR SPEED RELATIVE TO THE 158 (where 1 = 158)



D. AMDAHL MEETS/PRICE PERFORMANCE OBJECTIVES

● Generally on a price/performance basis Amdahl does even better than the results presented on a straight performance basis. One customer cited a 1.51 performance figure on benchmarks, but quoted a 1.9 to 1 advantage over the 168 on price/performance. The comparisons presented were against the 168 Model 1. The 168-3 provided a 5-13% performance improvement over the 168-1 but contained a price increase which kept price/performance relatively stable. The Attached Processor System has theoretical performance approaching Amdahl, but the increase in price still leaves the price/performance advantage with Amdahl.

● In summary, the original objective of 2 times the 168 performance was not achieved, but on a price/performance basis Amdahl is very close to meeting its objectives of providing twice the "bang for the buck".

IIIA. SURVEY RESULTS OF USERS WHO SELECTED THE AMDAHL SYSTEM

IIIA SURVEY RESULTS OF USERS WHO SELECTED THE AMDAHL SYSTEM

Ten users of the Amdahl 470V/6 were surveyed. Of these, four were commercial enterprises, three were universities, and three were computer services companies.

A. BETTER PRICE PERFORMANCE AND FASTER DELIVERIES

All ten Amdahl installations surveyed have replaced lower performance IBM equipment. Three installations replaced 370/168s, the other replaced smaller or older IBM equipment. This was expected since acquisition of a machine of this size implies prior heavy processing requirements. The two primary reasons motivating users to investigate Amdahl were:

- Need for additional capacity .
- IBM's inability to deliver the 370/168s within the user's time requirement.

Some users were motivated to leave IBM, because IBM increased prices on their installed equipment. Certain users perceive the initially unused extra throughput capacity provided by the Amdahl system as extending the potential life of that machine in their installations.

B. EVERYBODY NEEDS . . . MORE MEMORY

- Most users retained the existing configuration of peripheral equipment.

One user, by replacing two smaller machines with a 470V/6 was able to postpone the acquisition of several disk drives by utilizing drives previously dedicated to operating system software.

- Most users increased memory size over previous equipment and improved throughput. However, a majority of users did not utilize all channels available. One user eliminated three machines with one 470V/6 and actually reduced memory size and the number of channels used. (Exhibit IIIA-1)

- Most users who selected the Amdahl machine were candidates for 370/168s, as indicated by the fact that the 470V/6s acquired replaced one or more machines smaller than a 370/168.

C. THE LONG AND CAREFUL SELECTION PROCESS

- The study team assembled to evaluate the Amdahl 470V/6 versus the IBM. Participants ranged in number from 4 to 20 individuals. The average number of people on the team was between 6 and 8. The groups were mostly composed of technical types such as systems programmers, operations people, data processing managers, financial analysts, and one team included an attorney.

- Decision makers ranged in number from two people to a president and his full board of directors. Other decision makers involved in selecting Amdahl included by title:

- Chairman of Board
- CEO

EXHIBIT IIIA-1

MAINFRAMES REPLACED BY AMDAHL

PREVIOUSLY INSTALLED EQUIPMENT			AMDAHL 460V/6	
Model	Memory	Channels	Memory	Channels Used
370/158	1.5M	5	4M	?
360/75	3M	4	3M	?
370/155 (2)	2M (ea.)	4 (ea.)	4M	?
370/168	4M	3	4M	8
370/168	2M	5	4M	12
370/155	1.5M	5	2M	12
370/65 (2)	2.5M (ea.)	5 (ea.)	5M	15
370/158	2M	5	4M	8
370/158	2M	5	4M	16
370/168	4M	6	6M	12

- President
- Treasurer
- V.P. Research
- V.P. Finance
- Board of Regents of University
- V.P. Data Processing
- V.P. Marketing

• In all but one case the decision to acquire the Amdahl machine was unanimous among the decision makers.

• Objections to the acquisition were usually focused on Amdahl's continued viability as a company. This led to additional questions such as "What will IBM do in the future?" and "Can we depend on Amdahl for long-range support and maintenance?" One customer required a guarantee of future support by Fujitsu if Amdahl should fail.

• The average length of time users expect to keep the Amdahl machine ranges from four to more than eight years. Eight out of the ten users surveyed purchased the Amdahl equipment. (Leasing plans for Amdahl have just recently become available.)

D. FEW AMDAHL BUYERS ARE CONCERNED OVER FUTURE IBM DEVELOPMENTS.

• Most initial purchasers of Amdahl equipment are sophisticated users with a strong internal software capability. (Two have developed and use their own operating systems.) None expressed any major concern over future competitive developments. Remarks include:

- "By that time the 470 will be amortized."
- "IBM can't afford to obsolete all its applications programs."
- "We can use the 470 in another location if needed."
- "We'll be able to get rid of the 470 if they don't keep it up."
- "We have some concern about software if IBM withdraws support, but we think Amdahl will step in and support."
- "Our in-house operating system may make it impractical to take advantage of some of the possible new developments anyway."

- The most important factor responsible for a positive decision was increased throughput and improved price/performance.

- The decision time varied from one month to three years, however. Those who acquired the machine later took a shorter time to evaluate the system. After the evaluation was completed, the decision to buy took anywhere from one week (or simultaneous with conclusions of study) to 5 months. Most intervals were quite short.

- The most prevalent analyses performed included a financial analysis and visits to other users. Although the first customers who acquired Amdahl equipment ran extensive benchmarks, the later purchasers feel that this is no longer necessary.

E. BENCHMARKING, A DIMINISHING ISSUE

- Amdahl's policy of installing the machine for 60 days on trial permitted using the entire workload as a benchmark. Several users indicated that this was the only "Benchmark" that was made on the machine.

- One user who utilizes a standard benchmark to calibrate other configurations (used for facilities management contracts) tested the Amdahl machine and reported that it has 1.51 times the throughput of a 370/168. The same company estimates the price/performance of the 470V/6 to be 1.91 times that of a 370/168.

- Another user reported tests against several models of 370/168, as shown in Exhibit IIIA-2 where the base line (1.0) is a four megabyte 370/168 Model 1.

- All the users performed some type of financial analysis; however, only one attempted to quantify a price/performance ratio. Nevertheless, all mentioned this as a major factor in their decision.

F. AMDAHL 470V/6 EASY TO INSTALL AND PERFORMING TO EXPECTATIONS

- Users generally like the 470V/6. All but one user reported that the machine had equalled or exceeded his expectations. The one dissatisfied user reported an average up-time for four months of 97%. This was the first customer, and he attributed most of his problems to the channel-to-channel adapter. Others reported up-times ranging from 98% to 99%+.

- Every respondent reported a smooth conversion. Several said: "Better than IBM ever did." The system was brought up and was running production jobs in as little as twelve hours from the time the trucks arrived at the dock.

- One user, with an in-house developed operating system had Amdahl help for a week prior to the arrival of the hardware to help him modify

EXHIBIT IIIA-2

ONE AMDAHL USER'S BENCHMARK RESULTS

MODELS	168M1	168M3	168 APS	470V/6
RANGE	1.0	1.1	1.7	1.5
	1.0	1.2	1.9	1.7

his machine check recovery codes.

- Speed and throughput were the favorite features most frequently mentioned by users. Another frequently mentioned feature was the console mini-computer and the run-time diagnostics provided with the system. "More channels" was also mentioned as a positive feature.

G. IBM FOUGHT HARD TO KEEP THE ACCOUNTS.

- Most of the users interviewed indicated a strong response from IBM. A minority of the users indicated that IBM did little to keep the account. Two refused to comment on this question. Comments included the following:
 - "They pulled out all the stops."
 - "We got many visits from people in the region and even from people from Poughkeepsie."
 - "They offered to fly out technical people from Poughkeepsie."
 - "They didn't say it directly, but they warned us about what might happen to our hardware and software support if we left IBM."
 - "They brought in higher and higher levels of technical and marketing personnel, but they wouldn't answer some of our key questions that affected our in-house operating system."
 - " They tried to move up the delivery dates on their 168, but by that time it was too late."
 - "They brought out all the big guns to talk to my boss and his boss."
 - "They had friends of mine in IBM call me to talk me out of switching, but these guys were friends of mine and refused to do it."

- "They offered to fly me to Poughkeepsie in a private jet, but I turned them down."
- "The local branch manager sat in my office for hours. He almost cried."
- "They even got the bidding specifications restricted to 8 channels because that's all they could meet."

• In one situation, another vendor, other than IBM or Amdahl, went to the Board to force consideration of their equipment. They ended up making a presentation to the Board in competition with the data center staff which was recommending Amdahl.

H. AMDAHL MARKETING HAS THE PERSONAL TOUCH.

• There were few general comments on the subject of marketing except that Amdahl was as good as its competitors. Others who felt more strongly complimented Amdahl for its honesty and candor. They liked the personal touch of being able to call Eugene White or Dr. Amdahl if needed. This personal touch and the ability of a small company to go to the top seemed very important.

I. AMDAHL INSTALLATIONS PENETRATED BY PCM PERIPHERAL VENDORS

• Measured in terms of single density 3330 equivalents, the average user had 48 drives. The range of capacity was from 70 dual density 3330 type drives to a low of 10 single density 3330 type drives. Nine out of ten use PCM disk drives. Only two users were still using a small number of 2314 type drives. All but one was using non-IBM disk drives.

- Four users also had some type of mass memory device (CDC 8500 or STC Superdisk). The installation with the smallest disk capacity supplemented these with three STC Superdisks. Four users had IBM drum memory units.

- Random access equipment used by respondents is shown in Exhibit IIIA-3 with further detail on manufacturers in Appendix I.

J. IBM STILL DOMINANT IN TAPE DRIVES

- Several installations have linked Amdahl systems to other processors. In these situations the 470V/6 has access to all peripherals in the configuration. This explains the 70 dual density disk drives in one installation. It also explains the high end of the range in tape drives. The number of tape drives on the system varied from 64 to a low of 4. The average number of tape drives in an installation was 17. The majority of installations used IBM tape drives. The others had STC drives.

K. PRINTERS — NO PLUG COMPATIBLE PENETRATION

- All installations used IBM printers. The average number of printers per installation ranged from one to six 1403s and from one to three 3211s. One installation has two Decwriters in addition to their 1403s. One has no printer.

L. PROLIFERATION OF TERMINALS LEADS TO DISTRIBUTED PROCESSING.

- Most installations have RJE and terminal services available primarily on a dial-up basis. However, one user had 16 RJE stations and another 14

EXHIBIT IIIA-3

RANDOM ACCESS MEMORY CONFIGURATION OF AMDAHL INSTALLATIONS

3330 TYPE		PLUG COMPATIBLE		
Single Density	Double Density	2314 Type	Mass Memory	Drum Memory
SOURCE # OF DRIVES	SOURCE # OF DRIVES	SOURCE # OF DRIVES	# OF UNITS	SOURCE # OF UNITS
PCM/35*	IBM/24	IBM/6	1	IBM/2
	PCM/26			
PCM/20			1	
PCM/10		PCM/16	3	IBM/1
Mix/14	PCM/8			
Mix/75				
PCM/10	PCM/10			IBM/3
	PCM/70		1	
	IBM/30			IBM/3

* PCM = Plug Compatible Manufacturer

on dedicated lines. RJE equipment varied from 360-20s to Data 100 as well as everyone else's models and sizes. Terminals serviced by the system varied from a high of 400 to a low of 33.

M. TWO IS COMPANY; THREE IS A CROWD.

• Four out of ten users had no other machine on site besides the Amdahl 460V/6. The others had a variety of systems ranging from one to 28 other mainframes. The installation with the 28 mainframes used the PDP 11/40s as communication controllers and front ends. The other installations had (1) 370/158, (1) 370/165, (3) 370/168s, (1) HP 2000, (4) PDP8s, and (3) Memorex 1270s.

N. AMDAHL SYSTEMS INTERCONNECTING AND GROWING

• Half the surveyed users reported being connected into a network. At least one of the users considered the 500 incoming lines in his installation to be a "network." Four users reported their 470V/6s to be connected to one or more computers on the same site. Two of these have channel-to-channel adapters on the Amdahl machine which permit access to all peripherals on the other machines.

• Five users plan to increase the size of memory on their machines within the next year. Increases range from one to four megabytes.

O. NO MORE CHANNELS PLEASE

• Users stated that they do not see a need to increase channel capacity in the near future, since most are not yet using all the available channels.

Three users expect to acquire front-end computers (or additional computers) within the next year and two more might if volume requires it. Most users indicate that they are not satisfied with the mass memory devices available today. Three feel that they will become interested when mass memory technology improves. Three others indicated that they will install a bank of 3350s or an STC Superdisk in the near future to meet their needs and wait until a better mass memory becomes available.

P. RED CARPET FOR PLUG COMPATIBLE VENDORS

- All users indicated a willingness to use plug compatible devices. Most are using them already. Favored vendors at this time are Memorex, STC, and Itel. Users seem generally reluctant to discuss potential future PCM vendors.
- By contrast, however, third party maintenance services have made very limited penetration into the Amdahl installations. Two users had experience with third party maintenance vendors. Only one was still using such an arrangement (on Singer equipment). Most are using the manufacturer's maintenance service on equipment. They do not intend to consider other arrangements despite minor problems occurring occasionally in determining the responsibility for a failure. One computer services vendor has hired three of the manufacturer's C.E.s to resolve such problems and to provide service to his terminals in remote locations. Another has used the 16 channel capacity of the Amdahl machine to separate each vendor's equipment on its own channel to minimize potential conflicts. (Exhibits IIIA-4 & 5)

EXHIBIT IIIA-4

INVENTORY OF PERIPHERAL STORAGE EQUIPMENT

INSTALLED AT SITES OF RESPONDENTS

WHO SELECTED THE AMDAHL SYSTEM

INSTALLATION	DISK	NUMBER OF UNITS
1.	CDC - 3330 STC - Superdisk	35 1
2.	IBM 3350 IBM 2314	24 6
3.	Memorex 3675 IBM 2305	26 2
4.	CDC 3330 CDC 3850	20 1
5.	IBM 2305 STC 3330 STC Superdisk	1 10 3
6.	IBM 3330 Memorex 3330-1 Memorex 3330-2	8 6 8
7.	IBM 3330-1 Itel 3330-1	34 41
8.	IBM 2305-2 Memorex 3330-1 Memorex 3330-11 Memorex 2314	3 + 1 10 10 16
9.	Memorex 3330-11 STC Superdisk	70 1
10.	IBM 2305 IBM 3350 IBM 3330-11	3 8 30

EXHIBIT IIIA-5

SUMMARY OF INSTALLED PERIPHERALS

BASED ON 10 RESPONDENTS

COMPANY	MODEL NO.	TOTAL	AVERAGE PERIPHERAL COMPLEMENT PER SYSTEM
IBM	2305	10	1/System
IBM	2314	6	.6/System
IBM	3330-1	32	3.2/System
IBM	3330-11	30	3/System
IBM	3350	32	3/System
CDC	3330	55	5.5/System
CDC	3650	1	.1/System
STC	Superdisk	5	.5/System
STC	3330	10	1/System
Memorex	3330-1	16	1.6/System
Memorex	3330-11	114	11.4/System
Memorex	2314	16	1.6/System
Itel	3330-1	41	4.1/System
TOTAL		368	

IIIB. SURVEY RESULTS OF USERS WHO DID NOT SELECT AMDAHL

IIIB SURVEY RESULTS OF USERS WHO DID NOT SELECT AMDAHL

- Of the nine users of large scale computers surveyed who considered but did not buy the Amdahl machine, five are commercial accounts, two are computer services companies, one is a university, and one is a Federal Government installation.
- All installations surveyed planned to replace some existing equipment with the Amdahl machine had it been selected. Four specifically indicated that they were looking for some increase in capacity at minimum cost. The others tended to view Amdahl as a potential method of lowering existing cost.
- The most significant finding is that of the nine users who considered Amdahl only one actually upgraded his mainframe (158 to 168). Only one of the other users surveyed has altered his mainframe configuration or peripheral devices since the evaluation of the Amdahl equipment as shown in Exhibit IIIB-1 . This is significant since the survey included three very large users to whom the acquisition of peripherals or mainframes would be trivial indicating that the Amdahl evaluation was probably an exercise designed to explore ways to save money on current equipment rather than save on new equipment.

EXHIBIT IIB-1

COMPARISON OF USER EQUIPMENT CONFIGURATION

CONFIGURATION AT TIME OF AMDAHL EVALUATION				PRESENT CONFIGURATION			
USER	MODEL	MEMORY	CHANNELS	USER	MODEL	MEMORY	CHANNELS
A	370/168 (6)	3.5M (avg)	7-8 (ea)	A	U	U	U
	370/165	2M					
	360/30 (5)						
	7074 (2)						
B	370/158 (2)	3M (ea)	6 (ea)	B	U	U	U
	Cyber 70	1M	6				
C	370/168	2M	4	C	U	U	U
	370/168 (4)	4M (avg)	7-8 (ea)				
	370/158 (2)	2M (ea)	6 (ea)				
D	370/165	3M	6	D	U	U	U
E	370/155	3M	4	E	U	U	U
F	370/168 (4)	5M (avg)	12	F	U	U	U
G	370/158	2M	6	G	370/168	4M	7
H	370/168 (2)	6M (ea)	4 (ea)	H	U	U	U
I	370/168	3M	4	I	U	U	U

U = Unchanged

- The larger shops tend to share peripherals between mainframes so that it is not possible to assign a specific number of tape or disk drives to a given CPU. These figures and the calculated averages must therefore be used with caution.

A. IBM SELECTION RECOMMENDED BY STUDY TEAM

- The decision making process was identical to that of the users who chose Amdahl with the same numbers and types of people involved. In most cases the decision not to acquire Amdahl equipment was made during or at the end of the study phase and was made by the study group or its immediate superiors. Only if the equipment passed the test of the study group did higher level management get involved. In one instance, the study group recommended Amdahl, but the President of the company refused to accept the recommendation and ordered a 370/168 instead, basing his decision on the "uncertain viability" of Amdahl.

- Other than concerns about Amdahl's viability as a company, negative opinions were surprisingly few. Two companies had concerns in the technical area primarily related to execution time of certain instructions and operating system maintenance by Amdahl. One indicated that he felt Amdahl did not have enough experience in "big shop" environments. At least three were candid in saying that one or more people in their organization were afraid to leave the security of IBM.

B. HALF THE USERS BOUGHT THE EQUIPMENT

- One user who did acquire a new 370/168 after the study intends to

keep it for 5-6 years. Two users indicated they expected to acquire more equipment within the next two years, while one said that because he needs equipment right now he is still considering Amdahl for the near future. The surveyed sample was about equally divided among users who had purchased and those who leased the equipment. One user rented equipment or used short term leases to permit them to stay current with the state of the art.

- A real concern was expressed by only one user who wanted to know, "What will Amdahl do for an encore?"

- Elapsed time for the study of Amdahl equipment ranged from one to 18 months with an average of seven months, and for the most part the decision coincided with the conclusion of the study.

- All the surveyed companies performed financial analyses. Six ran benchmarks of various types. About half of the companies interviewed visited the Amdahl factory in Sunnyvale.

C. BENCHMARKS SHOW AMDAHL AHEAD

- Some companies had standard or synthetic benchmarks which attempted to measure performance objectively. The results achieved, as compared to a 370/168 M1, show that the Amdahl machine was not rejected for performance reasons. (Exhibit IIIB-2)

D. IBM INCREASES SERVICE WHEN COMPETITIVE MACHINES ARE CONSIDERED

- Almost all indicated some extra activity on the part of IBM to

EXHIBIT IIIB-2

BENCHMARKS

<u>BENCHMARK</u>	<u>PERFORMANCE</u>
Special Performance Jobstream	1.3 to 2.0
Applications Jobstream	1.3 to 1.6
Synthetic Workload	1.7
Single Stream	1.4 to 1.5
Batch Test	1.25
Standard Benchmark	1.7 to 1.8 times 168 - 3
TSS Simulation	1.6

retain the accounts; however, comments from several were guarded. A sample of comments follows:

- "They crawled all over us. They used red herrings, trying to scare us off of Amdahl. They were professional, but insistent."
- "The usual extra coverage when they heard we were looking."
- "We haven't let IBM know. We don't want that kind of pressure."
- "IBM was very interested in our benchmarks of the 470, because they thought they could learn something. Now they are coming back to talk to us about 168 architecture to keep us sold."
- "They are used to us shopping around. They didn't do much."
- "They were obviously concerned. They didn't put too much pressure on here, but I'm not sure what they did at corporate headquarters."
- "The usual IBM treatment . . . they talked to everyone who would listen, including the President."

E. AMDAHL MARKETING PERSONNEL IMPROVING

• Most users said Amdahl marketing was about equal to competition. One user indicated Amdahl marketing wasn't too good at first but is improving. Most users felt that their sales people are professional, competent, and technically qualified; however, some lack big shop experience. The most important strength was that the user could talk directly to Eugene White or Dr. Amdahl if necessary.

F. AMDAHL WILL BE CONSIDERED IN FUTURE BUYS

• A question was added to the survey to determine whether those

users who had not selected Amdahl would consider Amdahl in the future. Most respondents felt they would consider Amdahl again in the future. Two users indicated, however, that their own top management stood in the way of acquiring Amdahl equipment.

Some typical comments were:

- "We'll look again in 1978 when we need more gear to see what Amdahl has to offer and what IBM has done."
- "We wanted the Amdahl machine now but couldn't get the money appropriated."
- "We're still considering Amdahl for the near future."
- "We think it's the best price/performance machine available but we can't budge top management. They're afraid to move away from IBM."
- "We couldn't afford to change right now, while we can live with what we've got, but if and when we need a 168 size machine we will consider Amdahl if IBM has not become more cost-effective."
- "We recommended the Amdahl machine but the President was worried about Amdahl's viability and future support, so he picked IBM."
- "They would be a good buy for the regular type commercial shop, but we need to be state of the art with software and hardware. Their level of software support might keep us from using some of the latest peripherals. Also, they can't support some of the software we are now using."
- "We are not sure of the long-term resale value of the Amdahl machine."

G. IBM DOMINATES PERIPHERALS IN NON-AMDAHL INSTALLATIONS

1. DISK DRIVES TAPES AND PRINTERS IBM DOMINATES

- Measured in terms of 3330 equivalents, the largest user had 240 drives, the smallest, 30. The average user surveyed had 98. One user had two STC Superdisk units and one had an IBM 2305. (Exhibit IIIB-3)
- The largest users surveyed had exclusively IBM disk equipment and more users in this group tended to have exclusively IBM peripherals as contrasted to the group that selected Amdahl equipment. The inherent conservatism expressed by the unwillingness to use plug compatible peripherals seems to extend to the selection of the PCM mainframe. (Exhibit IIIB-4)
- Users indicated a range from a maximum of 125+ tape drives to a minimum of 10. The average number of drives per installation was 46. The majority of users had either all IBM drives or some mixture that included IBM drives.
- All installations used IBM printers. The 2 largest users had 20 printers each; the smallest had 2. One installation had 4 Xerox 1200s which were included in their count of 20 printers. The average is 8.

2. RJE STATIONS AND TERMINALS PROLIFERATING

- Two users indicated having programmable RJE stations on-line. (The other RJE non-programmable terminals were included with all other terminals.) Some users had as many as 500-600 terminals accessing their equipment, others as few as 25 terminals. The 25 were used in-house for

EXHIBIT IIIB-3

DISK DRIVES INSTALLED ON SURVEYED SYSTEMS

3330 TYPE				
SINGLE DENSITY	DOUBLE DENSITY	2314	MASS MEMORY	DRUM MEMORY
IBM 200+			PCM 2	
PCM 42				
IBM 30				1
IBM 100+				
	PCM 24			
IBM 240				
PCM 50				
	IBM 40			
IBM 80		IBM 48		

EXHIBIT IIIB-4

INVENTORY OF DISK STORAGE DEVICES AT SURVEYED
INSTALLATIONS WHERE AMDAHL WAS NOT SELECTED

INSTALLATION	MANUFACTURER	MODEL NO.	NO. INSTALLED
A	IBM	3330	200
	STC	Superdisk	2
B	IBM	3330	42
C	IBM	2305	1
	IBM	3330	30
D	IBM	3330	100+
E	Calcomp	3330	24
F	IBM	3330	240
G	IBM	3330	50
H	IBM	3330-11	40
I	IBM	3330-1	80
	IBM	2314	48
<u>TOTAL</u>			<u>857</u>
Average-%			95 /System
IBM Mkt. Share			831
Average-%			97

a highly interactive engineering design system. The average number of terminals was 200.

3. VARIOUS OPERATING SYSTEMS UTILIZED

- Due to the very large installations surveyed, there are a substantial variety of operating systems in use. Two key reasons for rejecting the Amdahl equipment were found in this area. One ASP user indicated that their tests showed that the Execute instruction heavily used by the ASP system did not execute as fast on the Amdahl machine. As a result the 470 did not provide the performance advantage that would have justified change to Amdahl. Another user with TSS on their 370/168 was afraid to change because they felt that IBM would no longer have the incentive to support TSS running on an Amdahl machine and Amdahl would not make a commitment to provide that support. These two examples are illustrations of some of the risks considered by users in their overall computer selection strategy.

4. INCREASING NETWORK INTERCONNECTION

- Three users surveyed were connected to large private networks. One user with 500 terminals within one year. Another is connected into a Federal Government network. Eighty percent of the users indicated that their computers were linked to other computers.

H. USERS PLANNING TO EXPAND CAPACITY

- Three users plan to increase memory size on their 370/168's during

the next year. One user plans to add another 370/168 to the four they now have. Few used front-end processors or expected to use them. IBM users indicated that additional channels were not needed. Almost all users studied their requirements for mass memory devices, but only one indicated a definite need during the next year. Most said that they are not satisfied with the IBM 3850 technology ("It's the data cell all over again."), and are willing to wait until something better comes along.

- All but one user indicated a willingness to consider plug compatible devices. However, in actuality most were exclusively IBM shops.

- All the users indicated that the equipment vendors provide maintenance on their systems. Only two users of the surveyed sample would consider use of a third party maintenance vendor. All others indicated definite opposition to the idea.

IV. IBM STRATEGIES/AMDAHL COUNTERSTRATEGIES

INPUT

IV IBM STRATEGIES/AMDAHL COUNTERSTRATEGIES

A. ALL IN THE FAMILY

- The causes of the emergence of Amdahl as a viable supplier of plug compatible IBM computers can be traced to certain decisions made by IBM in the late '60s and early '70s . Problems arose when IBM management made the assumption that a single family of computers could satisfy the full spectrum of user applications. This assumption was partly true in the '60s as shown by the outstanding success of the IBM System 360, but is not true in the '70s with the IBM System 370.
- The original 360 family had to be buttressed with new models such as the 360 models 22, 44, 67, and 9X to hold off competition. The 360/22 was a holding action at the low end, while System 3 was being developed. The 360/44 was used as a hedge against mid-range batch processing and real time scientific computers with better price performance. The 360/67 was introduced to satisfy the competitive thrust in the multi-user telecommunications-based systems. Finally, the 360/90 series was introduced to combat the penetration of computers like the CDC 6600 into the prestigious, complex scientific computation applications. In the current Justice-IBM litigation, these machines are called "fighting machines."

B. THE EXTENDED FAMILY

- With the introduction of the 138 and the 148, the price/performance disparity of the 158 becomes very obvious to most users. IBM has already lowered the price of purchased memory for 158 and 168 in line with MOSFET memory across the full range of System 370. By increasing the price/performance of the 158 by a factor of 1.7 to 2.0, the price/performance disparity among IBM models would disappear and the overall price/performance of the new 158 would overcome some of the arguments in favor of the Intel/National AS4 and AS5. Intel, however, has additional slack to meet IBM's price/performance improvements.
- The first customer shipment of the 158-3 occurred in September 1975, less than 6 months after announcement. It is likely that a successor to the 158-3 will be announced any time between now and March 1977 with shipments commencing between March and September 1977. Should such an announcement be made, it would temporarily impact the plans of customers who have committed to move to the Intel machines.
- The increase in the price/performance of the 168 will be more difficult to achieve in the short run. There are actions such as the integration of channels into the CPU and additional price cuts in memory, which could improve the price/performance of the 168 by 30% or 40%. However, a larger price/performance improvement which could hurt Amdahl would also be self-impacting on IBM. Therefore, INPUT does not believe that the short-term upgrade to the 168 will significantly impact Amdahl.
- If IBM announced a major price/performance improvement, there would be

a serious 6 month impact on Amdahl similar to the order hiatus that occurred when the IBM 360/90 was announced and orders for the CDC 6600 dried up. However, Amdahl has sufficient profit margins to enable them to react immediately as they did on memory pricing. Furthermore, Amdahl's development program seems to be sufficiently advanced to enable them to continue upgrading their system.

C. WILL IBM INTRODUCE FIGHTING MACHINES?

- The primary question discussed in this chapter is whether or not IBM will introduce a fighting machine against the Amdahl 470V/6. The introduction of the 370/168 APS may be considered as a partial response. INPUT believes, however, that this was only a partial solution which didn't seriously impact the growth of Amdahl. In fact, it is INPUT's position that since IBM did not introduce a fighting machine against the Amdahl 470V/6, it is likely that there won't be a fighting machine introduced against the 168 in the future.

- The IBM response will be designed to reduce the impact of all plug compatible mainframes in a manner designed to strengthen the competitive position of large IBM mainframes against all competitors. This response will occur 18 to 24 months from now and will be consistent with the distributed processor trend started by the 370/115 and 125. In the meantime there will be short-term, small, price/performance, feature and software improvements designed to slow down the movement to competitive mainframes and encourage migration to VM.

- There are a number of reasons supporting this opinion. During the '60s the management of IBM was very aggressive as evidenced by the internal IBM documents presented in current litigation. Although management does maintain an aggressive posture, that aggression is tempered by potential litigation and the impact on profitability of any new product program such as a fighting machine.

- The introduction of such a machine against the Amdahl 470V/6 would be a short-term strategy that would not solve the long term requirements for very large systems. The product development area which IBM is emphasizing is distributed processing which will be facilitated through new products developed in the Systems Communications Division. The fighting machines, such as the 360/22, 44, 67, and 9X were not profitable program products. There were only 1400 360/22 systems built by comparison with 13,000 360/20s and almost 4000 model 360/25s. Only 300 360/44s were installed at peak, while 12,000 360/30s and 6000 360/40s were built. Only 80 360/67s were ever built, while there were almost 800 360/65 systems.

- Last, but not least, the 360/9X had only 20 installations, most of which have since been converted to 370/195s. Based on the experience with such systems in the past, it is unlikely that IBM will offer a fighting machine against the Amdahl 470V/6. Before a detailed analysis of what IBM is likely to do against Amdahl, it is necessary to examine the context of IBM's overall strategy.

D. 'CARROT AND STICK' STRATEGY MOTIVATES THE USER TO UPGRADE

- The reluctant migration of users from one generation to the next is orchestrated and directed by IBM through a series of subtle and not so subtle moves.
- The apparent cause of migration is the combination of two factors: First, the user has reached a level of saturation where he can no longer put additional applications on his machine, and second, a new machine with improved price/performance must be available. Thus, before moving to the next machine, the user needs to reach a "threshold of pain" on his present equipment.
- Reaching the threshold on the 370 is accelerated by the implementation of virtual storage operating systems and telecommunications applications. The implementation of these two functions forces the user into larger and more powerful systems. However, the limitations within System 370, coupled with user inertia have slowed down the attainment of that threshold and kept many users from migrating from OS to VS and from batch to telecommunications.
- IBM, however, has strongly signaled its customers that they must move to VS by simply removing support for OS systems and by limiting their support to VS only on the recently announced 370 mainframes. In addition, the strategy of distributed processing currently being implemented by IBM implies that an increasing number of users will be moved by IBM into a telecommunications environment.

- As the user migrates to VS and telecommunications, the memory requirement increases dramatically. IBM has matched this requirement by constantly increasing the maximum amount of main memory available on each system and by lowering the price. The user is happy because he pays almost the same price or a little more for twice the memory.
- The migration to VS also increases the requirement for disk and tape peripheral capacity, but IBM has again managed to continue improving the price performance of the peripherals so that the user pays almost the same price (or a little more) for higher capacity and performance peripherals.
- This strategy of continual upgrading keeps the user from reaching the "threshold of pain" and keeps IBM's revenues intact until IBM is ready to announce its next generation of processors. Furthermore, this strategy positions the user into moving from one system level to the next until a majority of IBM users have reached or are approaching that threshold when they can be readily convinced to move to either a new or a next generation system.
- The migration of batch users to telecommunications and IBM's emphasis on distributed processing, is producing an increase in the level of sales of front-end communications processors, remote job entry systems, terminals, remote network node processors, etc. As the user upgrades his system into a distributed network he adds more and more equipment, which in turn places a greater burden on the host processor.

- These replacements will probably utilize architecture similar to the 115 and the 125, namely distributed microcoded subprocessors. The 115 and 125 contain an IPU (instruction processor unit) or MIP (machine instruction processor), an SVP (service processor) and IOPs (input/output processor). An SVP was recently added to the 168-3.

- The IOP does not require a separate data channel and a number of IOPs could be incorporated, thereby creating distributed architecture similar to that of a CDC 6600, a Honeywell 66 or 68, or a Burroughs 6700 machine. Such a distributed processor could have a throughput 2.5 times that of the comparable 158 and 168 and be quite competitive with the Amdahl machine which is only 1.7 times the power of the 168. These machines would essentially replace the 158 MP, the 168 MP, and the 168 APS.

- In addition, IBM would be in a position to start evolving more easily into the next generation by forcing the user to utilize VM and encourage him to use teleprocessing.

- The microcoded MIP and IPU subprocessors could also be micro-coded for specific selected functions and or applications. This would further increase throughput. IBM already uses a ROM in the 5100 to store the APL and PL/1 compilers. The language and operating systems overhead would be substantially reduced by utilizing software functions embedded in hardware. Other functions which could also be implemented include the kernel of the operating system and selected high usage utilities.

- The System Network Architecture (SNA) strategy encourages the user to increase his system utilization and to reach his threshold point more rapidly and thus be ready for the next generation of host processors.

E. PLUG COMPATIBLE MANUFACTURERS INTERJECT A SOUR NOTE

- Playing counterpoint in the carefully orchestrated strategy of moving users from one generation to another are the plug compatible manufacturers. After the peripheral manufacturers showed the way, the plug compatible mainframes are following in their footsteps.
- Having learned from past experience, IBM's response to the plug compatible mainframe manufacturers will be made more rapidly than its response to the plug compatible peripheral suppliers.
- After that the success of the plug compatible mainframe manufacturers depends on their business acumen and their ability to anticipate IBM's moves. IBM, on the other hand, always has to weigh the advantages of a strong competitive move against the possibility of impacting its own revenues and antagonizing its existing client base.

F. POWER TO THE DISTRIBUTED PROCESSOR

- IBM's long term response to the Amdahl's 470V/6's penetration into the 370/168 market and the potential penetration by the Intel/National Semiconductor AS4 and AS5 is likely to be two or more mainframes designed to upgrade the 158 and 168.

G. REMEMBER: MEMORY PRICES WILL DECLINE

- Lowering memory prices is one technique which IBM has used as a strategic countermeasure in straightening the competitiveness of selected models of the 370 family. By lowering memory prices, IBM has effectively altered the price performance of their systems. Exhibit IV-1 illustrates memory price changes from time of introduction to current prices for the various models and types of memories, calculated in terms of monthly rental per megabyte.
- MOSFET memory on the 370/138 and up is rented at \$5900 per month per megabyte; the pricing has not been changed. However, the reduction of 115 and 125 MOSFET memory to \$3,600 per month per megabyte foreshadows the possibility of a reduction of 148 and 158 memory to \$3,600 from \$5,900. Such a reduction represents almost a 40% cut.
- In an average 158 or 168 memory represents 25% of the price of the system. A 25% memory price cut would produce a 10% price/performance improvement.
- This move by itself may inhibit a small percentage of potential Amdahl customers from switching to the 470V/6 from the 168. However, it would not be sufficient to stop Amdahl. Amdahl could also easily match such a move by switching from 1K to lower priced (per bit) 4K chips, which it is already doing.
- The most extreme cut in memory prices would be a reduction to \$1,000 per month per megabyte. This is an 83% reduction and results in

EXHIBIT IV -1
 IBM'S MAIN MEMORY PRICE CHANGES
 FOR SYSTEM/370

MODEL	TYPE OF MEMORY	MAC (\$000)/MO/MB	
		INTRODUCTION	CURRENT
115	MOSFET	9.4	3.6
125	MOSFET	7.2	3.6
135	BIPOLAR	19.2	11.0
138	MOSFET	5.9	5.9
145	BIPOLAR	19.2	11.0
148	MOSFET	5.9	5.9
155	CORE	12.0	2.2
158	MOSFET	5.9	5.9
165	CORE	12.0	.8
168	MOSFET	5.9	3.6

a 20% improvement in price performance. Although this level of price reduction by IBM would seriously hurt competition, it is highly unlikely since everyone's profitability would be substantially curtailed.

- When IBM reduced the purchase price of 158 and 168 memories in May 1976 by 35% from \$263,000 to \$170,000 per megabyte, but held the lease rate at \$5900 per megabyte, Amdahl followed. The \$170,000 purchase price is equal to \$3600/month/megabyte. This was a selective price cut taken by IBM which reduced the profitability of Amdahl without seriously affecting the other vendors.

H. INTEGRATING DATA CHANNELS INTO THE MAINFRAME

- Another strategy which IBM might employ is to integrate data channels into the processor and offer a corresponding price reduction. In interviewing ten users of the Amdahl 470V/6 we found that the average number of data channels on replaced IBM systems was 4.8. With the purchase price of data channels varying from \$112,000 to \$250,000 plus special features, it doesn't take too many channels to accumulate \$1,000,000 in the cost of data channels alone.

- Integrating data channels into the mainframe would have the same effect on prices as IBM-offered integrated storage controllers (ISC) instead of stand-alone controllers. The integrated controllers produced savings of up to 20% when comparing the price of the ISC versus the 3830.

I. MULTIPLE MAINFRAMES AND SPECIAL FUNCTION PROCESSORS LEAD TO DISTRIBUTED PROCESSING

• Currently, IBM can equal the performance of an Amdahl 470V/6 with either a closely coupled 168 MP or a 168-3 with an APS. However, what would happen to IBM's argument if the 470V/6 were configured as a dual processor? Let's suppose that Amdahl offered the equivalent of a 168 APS Processor at 1.4 times the 470V/6 price. Now the IBM 168-3/APS system is equivalent to an Amdahl 470V/6 in performance but is still more expensive. An Amdahl dual 470V/6 on the other hand would have three times the performance of a 168-1 at the same price as the IBM 168-3 APS. IBM could never win with the 168 against the dual 470V/6. In fact, a dual 470V/6 would be almost two times the computing power of a 370/195! Therefore, it is obvious that IBM must do more to combat the Amdahl inroads.

• One of the new features of the IBM 168-3 is the use of a service processor similar to that employed in the models 115 and 125. The service processor logs data for both recoverable and non-recoverable errors, thereby expediting on-line error analysis. This capability already exists in the Amdahl 470V/6. Some users have also used either software or hardware performance monitors to help them to upgrade system performance by recoding to balance and fine tune applications which are core or I/O bound. Amdahl could include such a software package either in the mainframe or on the Nova minicomputer, Amdahl's equivalent to the IBM service processor. The inclusion of

this capability by Amdahl will allow fine tuning of applications producing a higher level of throughput.

- Increasing the size of the high speed buffer from 16K bytes to 32K bytes increased the throughput on the IBM 168-3. The Amdahl 470V/6 has a high speed buffer of 16K bytes which could be increased to 32K bytes. Apparently this change would result in a throughput increase of from 5 to 13%. Should IBM ever increase its high speed buffer to 64K bytes, it is likely that Amdahl could match the change.

J. IBM MAY ACCELERATE THE INTRODUCTION OF A 168 UPGRADE

- INPUT considers that IBM's current plans are for a 370/168 upgrade in the 1977-78 timeframe. It is a possibility that there will be an acceleration in this IBM timetable. However, INPUT discounts this possibility because the current 370/168 backlog insures that IBM will continue shipping 168s at the current rate during the next year. Therefore, any price cut would be self-impacting. The 158 backlog is more limited. Therefore, it is likely that IBM will introduce a 158 replacement by the end of the year.

- Should there be a 168 upgrade in the near future, however, the worst that could happen to Amdahl is to be forced to fall back to the "low" forecast. Amdahl would continue to be viable, although its future market potential would be severely limited. Amdahl, however, in the short run, would probably be capable of responding to most upgrades likely to be announced by IBM.

- Another reason to doubt the acceleration strategy for the 168 is that, although this strategy may be desirable if IBM wants seriously to impair Amdahl as a viable competitor, it would produce a serious legal risk. The Amdahl case could be used by the Justice Department against IBM in monopolistic litigation; additionally, there is the serious possibility that IBM would be sued by Amdahl.

- The negative experience by IBM in selectively releasing systems too soon and the corresponding impact on IBM's revenues have not been forgotten by management, as evidenced by the continued delays of system FS. The main IBM strategy and challenge is to meet present and future competitive systems challenges, preserve its revenue base, and enable the user to maintain his investment in applications running on Systems 360 and 370. IBM's future success is based on its ability to maintain a continual revenue stream rather than meeting the Amdahl challenge.

K. IBM MAINTAINS SOME CONTROL OVER MOST AMDAHL USERS

- The Amdahl computer user employs IBM compatible software. Thus IBM receives revenue from Amdahl customers for licensed software and IBM peripherals (where installed) and is, therefore, aware of the relative position of the Amdahl user with respect to his threshold. At the same time, IBM will continue to develop new peripherals with the potential of surrounding the Amdahl system with more and more IBM equipment.

- IBM's position is maintained indirectly because of its software and peripherals control. IBM could also impact Amdahl by changing the

relationship between the processor and the software. In some cases our survey found that the Amdahl system was rejected because certain applications ran slower on the Amdahl system than on the IBM 168. Hence, IBM could conceivably capitalize on these comparative weaknesses by implementing changes in new releases of software packages with instructions which operate faster on the IBM system than on the Amdahl system. Amdahl has responded by generating engineering changes to equal or exceed IBM's instruction speeds.

- If any of the engineering changes make the 470V/6 diverge from the IBM 370/168 Amdahl will be in a vulnerable position. First, because it would have to increase its staff of programmers to keep its machine compatible with IBM, thus entering a contest it could not win in the long run. Second, if it could not maintain compatibility, it would limit its market to those customers who are software independent of IBM.

L. WHAT WILL IBM REALLY DO?

- The IBM strategy is complex and multifaceted because it has to take into account financial, marketing and legal considerations. Therefore, IBM's pricing policy will be constrained by the above requirements resulting in a predictable, gradual improvement in price/performance.
- Although the immediate impact on IBM revenues of Amdahl is small, because most of the systems which Amdahl is replacing have been purchased and IBM has already been paid for them, the real impact on IBM is to reduce the available market for the System 370 follow-up. Since

the peak years for the 158 and 168 were planned to be 1977 and 1978, respectively, and the Amdahl and ITEL plug compatible mainframes present a serious threat, it is likely that a new system will be accelerated and announced in 12 to 24 months.

- In 1977, IBM's growth in revenues will be centered around products offered by the General Systems Division and the new peripherals for System 370. IBM's strategy in distributed processing will be to surround the data processing complex with a growing network of machines where the host processor will represent a diminishing fraction of the total system.
- By not totally inhibiting Amdahl's success, IBM will have clear evidence that there are no barriers to market entry and, therefore, by implication that IBM is not a monopolist. The benefits to IBM of allowing Amdahl to co-exist far outweigh the potential future revenues which would be produced by Amdahl's disappearance. (See Exhibit IV-2).

M. HOW AMDAHL CAN REDUCE ITS VULNERABILITY

- To increase account control and increase its market potential, Amdahl must consider offering an increasing portion of the total system. This implies that Amdahl must begin offering controllers, peripherals, front-end communications processors, terminals, etc. These in turn must be plug compatible to insure the user's "escape hatch" back to IBM.
- Amdahl may utilize a similar strategy with the new equipment as it did with its processor. For example, the Amdahl 470V/6 has an LSI channel section and a separate channel selector that makes the Amdahl

EXHIBIT IV -2

TIME FRAME OF POTENTIAL IBM RESPONSES

RESPONSE	NEXT 6 MONTHS	12 MONTHS	24 MONTHS
Lower Memory Prices	•		
Integrate Data Channels into Mainframe and Reduce Prices	•		
Increase Size of H. S. Buffer	•		
Modify 158 & 168 Architecture by Converting Mainframe into Series of Multifunctional Processors		•	•
Utilize Relocatable Control Storage to Put O/S Kernels into Long Range Functions to Decrease System Overhead		•	
Utilize New Memory Technology to Lower Prices		•	•
Unbundle Prices of Hardware Operating Systems		•	•
Put O/S Software into Hardware, Change Channel Interfaces to Increase System Security and Reduce Compatibility Technology		•	•
New Component Technology to De- crease Number of Components in Package		•	•

channels look like IBM channels. If Amdahl were to develop its own controllers, it could attach these controllers directly to the LSI channel and bypass the channel section which is IBM plug compatible. These controllers could employ the latest LSI technology and appear to the peripherals as plug compatible.

- These controllers could be integrated into the processor in the same manner as the integrated units available from IBM. Such a technique would improve I/O throughput since the conversion through the IBM channel feature would be bypassed. The design of LSI controllers would lower manufacturing cost, and would result in smaller and more powerful units than those available from IBM.
- The issue of whether Amdahl should offer peripherals with its system is potentially a double edged sword.
- Because Fujitsu is a major investor in Amdahl, it will be marketing a derivative of the Amdahl system in Japan. Outside Japan Amdahl and Fujitsu will market the 470V/6 as partners except in Canada and the U. S. where Amdahl is the exclusive marketing agent.
- Fujitsu manufactures a line of peripherals which are plug compatible with IBM. Amdahl could offer these peripherals in the U. S. and Canadian market as part of its system by buying them from Fujitsu on an OEM basis. This type of strategy would enable Amdahl to offer a complete system.
- This strategy could, however, have negative repercussions, since it is the existing plug compatible manufacturers who have opened the market

for the Amdahl processor. If Amdahl starts to compete with them, they in turn will make a major effort to secure plug compatible mainframes to compete with the Amdahl processor. Therefore, although the revenues and profitability of Amdahl would be increased by offering complete systems, the company would be diluting resources from its area of proven competence.

- Therefore, it is likely that in the foreseeable future Amdahl will work closely with PCMs to reduce IBM account control rather than enter into direct competition with peripheral PCMs.

- The common goals among all PCMs, whether peripheral or processor, are the attainment of market penetration and the reduction of IBM's account control. These goals can only be accomplished by maintaining improved price performance over IBM. With these common goals, the PCM's can remain successful by focusing their product activities in their primary area of competence.

- In the Japanese market in particular and in the international market in general, it is likely that the Fujitsu/Amdahl marketing strategy will emphasize a complete system solution.

- The major area of opportunity for Amdahl during the next 2 to 3 years is concentration on upgrades and downgrades of its present mainframe with perhaps some development activity in the communications processor area.

V. GROWING MARKET FOR LARGE MAINFRAMES

V GROWING MARKET FOR LARGE MAINFRAMES

- The market which Amdahl has entered represents about \$9.0 billion in cumulative revenue for IBM by 1980. To achieve a classical plug compatible penetration of 20% represents a cumulative potential revenue of \$1.8 billion to Amdahl. However, the maximum potential revenue to Amdahl is almost \$3 billion! These revenue projections are worldwide and do not include peripherals. The basis for these projections is shown in Exhibits V - 1, 2, 3, 4, 5.

A. TWENTY PERCENT PENETRATION FOR PLUG COMPATIBLE MAINFRAMES

- There will always be a segment of the IBM user community who do not like the feeling of being controlled by IBM. These users develop their own specialized operating systems, procure plug compatible peripherals, lease their systems from third parties, buy software packages instead of developing them in-house, and migrate to telecommunications systems after carefully evaluating whether such a change is warranted by their particular needs. This portion of the market, which we have estimated to be 20%, will provide the Amdahl type of computer with its most ready acceptance. The Bell Telephone companies are a prime example of this

type of customer.

- There is also a substantial portion of users overseas who either because of nationalistic or other motives feel that IBM does not always offer the best price/performance but are still committed to IBM because of software. A portion of the international market is ready to move to Amdahl 470V/6 or similar machines. Many of these customers are also concerned with the IBM market share in their country and are looking for any reasonable avenue to reduce IBM's influence without impacting their own viability. These are positive factors in Amdahl's favor which they will undoubtedly exploit as their market efforts expand overseas.

B. PENT-UP DEMAND FOR LARGE SYSTEMS

- Another major issue when analyzing Amdahl's viability is the lateness of the introduction of the Amdahl system as compared to the life of systems which it is replacing. Additionally, there is the question of whether there will be a market for the used, purchased processors which are being replaced. The peak installed year for the 158 is expected to be in 1976, while the 168 will reach its peak in 1977. In both instances this is a year sooner than the average IBM product cycle projection. Both systems have a purchase content of over 50%.

- Only seven of the 13 systems replaced in INPUT'S sample of 10 Amdahl systems were 158s and 168s; the others were 360s or 370/155s. In addition, the demand for used 360s and 370s exceeds the rate at which Amdahl systems are being installed. Of the potential 3500 systems capable of being replaced, the distribution and replacement percentages

are shown in the following table. The replacements will probably follow the indicated percentage distribution over the long-term, even though there is some deviation at this time. The current pent-up demand for these systems is shown for the U. S. in the last column of the following table. (Exhibit V-1)

• Exhibit V-2 shows that current demand for used systems will more than equal the production of Amdahl 470V/6s. The market demand five years from now should be able to absorb any used 470V/6 systems becoming available as a result of displacement by the next generation of IBM computers.

EXHIBIT V-1
SYSTEM DISTRIBUTION
YEAR-END 1975

MODEL	PERCENTAGE OF SYSTEMS RE- PLACED BY AMDAHL	PERCENTAGE DISTRIBUTION OF IBM SYSTEMS IN U.S.	PERCENTAGE DISTRIBUTION OF IBM SYSTEMS WORLDWIDE	PENT-UP U. S. DEMAND FOR USED SYSTEMS
360/65	15.4	17.9	17.2	10
360/75	7.6	1.1	1.1	
370/155	23.1	22.5	25.7	25
370/158	30.8	40.4	40.0	125
370/165		4.5	4.6	
370/168	23.1	13.5	11.4	35

EXHIBIT V-2

INSTALLED BASE (UNITS) IBM LARGE COMPUTERS

YEAR-END 1975-1980

MODEL	U. S.	INTERNATIONAL	WORLDWIDE
360/65	400	200	600
360/75	25	12	37
370/155	500	400	900
370/158	900	500	1,400
370/165	100	60	160
370/168	300	100	400
Total Systems (1975)	2,225	1,272	3,497
20% Penetration	445	254	699
Total Systems (1980)	3,840	3,521	7,361
20% Penetration	768	704	1,472
CUMULATIVE AMDAHL MARKET POTENTIAL IN UNITS - 1980*			
	U. S.	INTERNATIONAL	WORLDWIDE
• High	768	704	1,472
• Median	384	352	736
• Low	192	176	368

* The 1980 potential is calculated on the basis of 1975 installations. The total number of large systems will continue to grow between 1975 and 1980. Therefore, the worldwide potential for the Amdahl 470V/6 and its followers will be about 1500 machines worldwide. The more that Amdahl extends its product line, the greater the replacement market potential becomes.

EXHIBIT V-3

AMDAHL REVENUE FORECAST

(\$4 MILLION/SYSTEM)

(INPUT Estimates)

AMDAHL REVENUES	1975	1976	1977	1978*	1979*	1980*
U. S.						
High	24	100	200	400	560	512
Median	24	90	120	200	200	120
Low	24	80	100	144	48	0
International						
High	0	8	132	356	320	208
Median	0	6	80	200	200	152
Low	0	4	60	120	80	0

* The 1978 - 1980 estimates do not take into account the potential Amdahl follow-up products.

EXHIBIT V-4

AMDAHL CUMULATIVE 1980 REVENUES*

(\$ BILLION)

REVENUES	PROCESSORS	ADD-ON MEMORY
U. S.		
High	1.80	.06
Median	.75	.03
Low	.42	.02
International		
High	1.02	.04
Median	.64	.02
Low	.26	.01
Total		
High	2.82	.10
Median	1.39	.05
Low	.68	.03

* These numbers don't include any revenues for add-on peripherals or other new products, such as a new mainframe or communications controller.

EXHIBIT V-5
AMDAHL SHIPMENT FORECAST
(\$ MILLION)

(INPUT Estimates)

AMDAHL SHIPMENT	1975	1976	1977	1978*	1979*	1980*
High	6	32	83	189	220	180
Median	6	31	50	100	100	68
Low	6	30	45	66	32	0
High Total	6	32	83	189	220	180
U. S.	6	30	50	100	140	128
International	0	2	33	89	80	52
Median Total	6	31	50	100	100	68
U. S.	6	29	30	50	50	30
International	0	2	20	50	50	38
Low Total	6	30	45	66	32	0
U. S.	6	29	30	36	12	0
International	0	1	15	30	20	0

* The 1978 - 1980 estimates do not take into account the potential Amdahl follow-up products.

VI. OPPORTUNITIES FOR THIRD PARTY VENDORS

VI OPPORTUNITIES FOR THIRD PARTY VENDORS

A. PERIPHERALS OPENED THE DOOR.

- The Amdahl 470V/6 and other IBM plug compatible mainframes offer excellent opportunities for third party vendors including plug compatible peripheral manufacturers, software products vendors, used computer brokers, and, to a much smaller extent, third party maintenance companies. Once a company makes a commitment to Amdahl or other plug compatible mainframes, the "IBM account" barrier is overcome. With this barrier lowered, the opportunity to introduce additional plug compatible equipment is increased.
- More frequently, however, it is the plug compatible peripheral manufacturer who has penetrated the account first and opened the door for Amdahl by performing successfully in the formerly all-IBM account. Since the introduction of plug compatible peripherals into the IBM account was not followed by lightning, pestilence, or other Biblical retributions, when Amdahl presented the advantages of the 470V/6, the evaluation was often unemotional and businesslike.
- Plug compatible manufacturers offering disk drives, tape drives, communications controllers, and printers can attach their peripherals to the Amdahl system since the 470V/6 was designed to use either IBM or IBM

plug compatible peripherals. Due to the unique nature of the memory on the Amdahl system, this opportunity is limited for the add-on memory manufacturers.

- Currently, plug compatible manufacturers offer savings of 10% to 15% over IBM, and, in some situations, this can grow to 20%. The penetration of plug compatible manufacturers has always been higher on the larger systems than the overall average penetration level of 20%.

- The installed base of Amdahl systems is expected to grow from a level of 25 systems currently to well over 100 in the 1978-1979 time frame. It is also expected that IBM will have increased the installed base of IBM 370/168s from 400 to 500 during the same time period. This means that Amdahl is likely to capture 20% of the 370/168 base, comparable to the traditional penetration of plug compatible peripheral manufacturers.

- Attached to each of the Amdahl systems is a large number of peripherals from plug compatible manufacturers.

- The average number of disk drives per system of both single and double density 3330 type drives is 35. As shown in Exhibit VI-1, this alone represents a market for 3500 drives and about 440 controllers. The value on an "if purchased" basis on the disk drive market attached to Amdahl computers is almost \$123 million.

- The average for tape drives per system is 16 units. This represents a market for 1600 drives and 200 controllers with a corresponding market value of \$40 million.

- The number of printers is estimated at 350 for a total market value of almost \$17 million.

EXHIBIT VI-1

PERIPHERALS MARKET POTENTIAL

HARDWARE	QUANTITY	MARKET VALUE \$M
Amdahl 470V/6	100	400
Disk Drives/Controllers	3500/440	123
Tape Drives/Controllers	1600/200	40
Printers	350	17
Communications Processors	100	10
	Total Potential	590
	Peripheral Total	200
	Peripheral %	34%

- The communications processor market is estimated at 100 units with a total market value of \$10 million.

- Accumulation of these projections shows that peripherals represent only 34% of the value in an average Amdahl installation.

B. AMDAHL PERIPHERALS — THE FUJITSU CONNECTION

- The probability of Amdahl offering peripherals with its system at some time in the future is high.
- One of the major investors in Amdahl is Fujitsu, which manufactures a complete line of IBM compatible peripherals. Currently, Memorex is a licensee of some Fujitsu peripherals, and Memorex may market the lower end of the Fujitsu M series computers in the U. S. in the future.
- Either Memorex or Amdahl may purchase peripherals from Fujitsu for attachment to Amdahl systems. It is unlikely that this will occur before 1977.
- However, in order to increase revenues and account control, Amdahl marketing strategists must consider adding peripherals and controllers in the 1977-1978 time frame. Should this occur, there would be a serious impact on all of the other plug compatible manufacturers.
- The risk by Amdahl of employing such a strategy is to create additional competitors by encouraging the development of additional plug compatible mainframes.

C. LIMITED OPPORTUNITY FOR THIRD PARTY MAINTENANCE

- In almost all cases, maintenance on plug compatible peripherals is performed by the manufacturers themselves, as demonstrated by Exhibit VI-2. In Amdahl's case, it provides a combination of on-site and remote maintenance services. This implies that the opportunity for third party maintenance in plug compatible mainframe installations is limited to IBM and DBM compatible peripherals which represent only 34% of the total, as shown above, and therefore is not very attractive to third party maintenance companies such as Sorbus and Raytheon.

- However, if companies who are purchasing the Amdahl machines already have third party maintenance agreements for other equipment, the new equipment (less the processor and main memory) may be attached to the existing agreements.

D. INCREASED OPPORTUNITIES FOR SOFTWARE VENDORS

- The opportunities for suppliers of software packages is enhanced by the Amdahl 470V/6. As the performance of the system improves, the desirability of adding new applications becomes more attractive. Having purchased a non-IBM mainframe, the user is more amenable to considering off-the-shelf non-IBM software packages designed to operate on the IBM 370 computer. Therefore, the software packages vendors should track Amdahl installations as potential sources of preconditioned customers for IBM compatible applications software.

- Additionally, both Amdahl and its users are potential customers for

EXHIBIT VI-2

THIRD PARTY MAINTENANCE

MANUFACTURER / LEASE COMPANY	MAINTENANCE COMPANY	DEVICE
Ampex	Ampex	Disk
Calcomp	Calcomp	Disk and Tape
Control Data Corp.	Control Data Corp.	Disk and Tape
Itel	Itel	Disk and Tape
Memorex	Memorex	Disk
Mohawk	Mohawk	Tape
Potter	Raytheon	Tape
Randolph	Telex/Sorbus	Disk
Storage Technology	Storage Technology	Disk and Tape
Telex	Telex	Disk and Tape
	Sorbus	
	Raytheon	

non-IBM systems software, such as compilers and operating systems. Computer Usage Corporation has had major software development contracts with Amdahl in this area.

E. MORE LARGE MAINFRAMES AVAILABLE TO USED COMPUTER BROKERS

- As Amdahl continues to penetrate the market, the availability of used large IBM systems will grow. Based on our sample and assuming a range of 1.3 to 1.8 computers being replaced by each Amdahl 470V/6, a sizable used computer market can be anticipated for the three levels of Amdahl penetration described in Chapter V. (Exhibit VI-3)
- Depressing the price of currently installed IBM equipment are the following factors:
 - Replacement by Amdahl
 - Replacement by other plug compatible mainframes
 - Continuing IBM upgrades
 - Threat of announcement by IBM of a new generation of mainframes.
- The price of the used equipment may in fact become so depressed that the price/performance becomes attractive, causing some backward migration similar to the 360/65.
- Based on these assumptions, we may assume that the average value of a 168 will be 20% of its original value, namely about \$600,000 per system by 1980. On the basis of the cumulative number of systems replaced, Exhibit VI-4 shows the market for computers replaced by the Amdahl 470V/6.
- The availability of these mainframes will present increased business

EXHIBIT VI-3
REPLACED COMPUTERS
(units)

(INPUT Estimates)

MAINFRAMES	1975	1976	1977	1978	1979	1980
High Total	7	21	83	189	220	180
360/65	4	4	14	33	38	31
360/75		1	1	2	2	2
370/155		5	21	49	56	46
370/158	1	8	33	75	88	72
370/165	1	1	4	9	10	8
370/168	1	2	10	21	26	21
Median Total	7	21	50	100	100	68
360/65	4	4	8	18	18	12
360/75		1	1	1	1	1
370/155		5	13	26	26	17
370/158	1	8	20	40	40	27
370/165	1	1	1	5	5	3
370/168	1	2	7	10	10	8
Low Total	7	21	45	66	22	0
360/65	4	4	7	12	4	0
360/75		1	1	1	0	0
370/155		5	12	17	6	0
370/158	1	8	18	26	9	0
370/165	1	1	1	3	1	0
370/168	1	2	6	7	2	0

EXHIBIT VI-4

USED COMPUTER REVENUES

RANGE	(\$ MILLION)
High	400
Median	203
Low	94

opportunities for the used computer brokers. Computer services companies will also be able to take advantage of the lower prices.

● In some cases of upward migration (i.e., for users with 155s or 158s) Amdahl will be competing not only with current IBM 168 type equipment but also with used 168s at significantly lower prices.

APPENDIX I. PLUG COMPATIBLE MANUFACTURERS

APPENDIX I PLUG COMPATIBLE MANUFACTURERS

• The lists of plug compatible manufacturers and their products are shown in the following tables.

DISK DRIVES

<u>Plug Compatible Company</u>	<u>Model Number</u>	<u>IBM Model Number</u>
Ampex	DS 330-1	3330-1
	DS 330-2	3330-2
	DS 331	3330-11
Calcomp	1030	3330-1/2
	1035	3330-11
Control Data Corp.	33301	3330-1/2
	33302	3330-11
Itel	7330-1/10	3330-1/2
	7330-11	3330-11
Memorex	3670-1	3330-1
	3670-2	3330-2
	3675	3330-11
Randolph Computer	RCC 7330	3330-1/2/11
Storage Technology	8100	3330-1/2

DISK DRIVES

<u>Plug Compatible Company</u>	<u>Model Number</u>	<u>IBM Model Number</u>
Telex	6330	3330-1/2/11
	8330	3330-1/2/11

TAPE DRIVES

Calcomp	345	3420-5
	347	3420-7
Control Data Corp.	34201-3	3420-3
	34201-4	3420-4
	34201-5	3420-5
	34201-6	3420-6
	34201-7	3420-7
	34201-8	3420-8
Mohawk	8420-3	3420-3
	8420-5	3420-5
Potter	AT3423-1	3420-3
	AT3425-1	3420-5
	AT3427	3420-7
Storage Technology	3430	3420-3
	3450	3420-5
	3470	3420-7
	3630	3420-4
	3650	3420-6
	3670	3420-8
Telex	6420-3	3420-3
	6420-5	3420-5
	6420-7	3420-7
	6420-44	3420-4
	6420-66	3420-6

PLUG COMPATIBLE PRINTERS

<u>Plug Compatible Company</u>	<u>Model Number</u>	<u>IBM Model Number</u>
Control Data Corp.	28211/14031	1403N1
Potter	Grand Slam	1403N1
Telex	5403/5821	1403N1
	6721	1403N1

COMMUNICATIONS PROCESSORS

<u>Plug Compatible Company</u>	<u>Model Number</u>
Action Communications Systems Telecontroller	
American Systems	Nucleus 4000
Collins Radio Group	C-System 8562
Computer Communications Inc.	CC-8
	CC-80
	CC-8000
Computer Transmission Corp.	M-3000
Comten Inc.	Comten 476
	Comten 3650
	Comten 3670
Control Data Corp.	Cyber 1000
Data General	Nova 2
	Eclipse Nova 3
	Eclipse S/1000
	Eclipse S/200
	Eclipse S/300

Communications Processors (continued)

Plug Compatible Company

Model Number

Data Pathing Inc.

Series 2000

System 150-30

System 150-60

Series 2100

Digital Communications Association

Smart/MUX

Digital Computer Controls

D-116

Digital Equipment Corp.

Front End System Base

GSC Data Systems

T-578

GTEIS

IS/1100

IS/1101

IS/1102

Harris Corporation

4705

CO-65

Interdata

Model 8/32

Model 6/16

Model 7/32

Memorex

1270 D4A

1270 D5A

1270 D6A

1380

Modular Computer

Modcomp II CP

Modcomp IV CP

Norfield Electronics

DCS400

Communications Processors (continued)

<u>Plug Compatible Company</u>	<u>Model Number</u>
Periphonics	T-Comm 7
RCA Global Communications	Miniplus
System Engineering Lab	SEL 32
Telefile Computer Products	TCP-64
Telex	6705
Texas Instruments	EMS II
	DXS
	700 TPS
Univac	3760
Varian Data Machines	V72
	V73/74
	V75
	V76

APPENDIX II. INTERNAL PERFORMANCE 470V/6 VS. 168 AND 158

INPUT

APPENDIX II - INTERNAL PERFORMANCE 470V/6 vs 168 and 158

OPERATION		168	158
BALR	05	1.08	3.09
BCTR	06	1.13	3.29
BCR	07	3.24	5.68
LPR	10	2.31	6.00
LNR	11	2.31	5.39
LTR	12	1.18	5.37
LCR	13	2.31	6.63
NR	14	1.24	12.13
CLR	15	1.20	5.54
OR	16	1.22	12.13
XR	17	1.22	12.12
LR	18	1.22	5.54
CR	19	1.24	5.65
AR	1A	1.10	6.14
SR	1B	1.11	6.92
MR	1C	2.31	6.42
DR	1D	1.06	5.50
ALR	1E	1.10	4.97
SLR	1F	1.09	4.95
LPDR	20	.72	5.36
LNDR	21	.72	5.37
LTDR	22	.73	5.52
LCDR	23	.72	7.08
HDR	24	2.05	7.10
LRDR	25	2.16	5.76
MXR	26	1.23	6.18
MXDR	27	.80	9.29
LDR	28	.74	4.03
CDR	29	1.84	18.66
ADR	2A	.93	13.96
SDR	2B	.94	13.06
MDR	2C	.80	4.39
DDR	2D	.98	9.95
AWR	2E	1.07	9.24
SWR	2F	1.08	8.65
LPER	30	1.26	8.66
LNER	31	1.50	8.66
LTER	32	1.25	8.66
LCER	33	1.25	12.12

OPERATION		168	158
HER	34	3.59	8.18
LRER	35	2.86	7.95
AXR	36	1.52	9.81
SXR	37	1.56	9.23
LER	38	1.37	5.62
CER	39	3.25	21.01
AER	3A	2.57	16.87
SER	3B	2.69	16.86
MER	3C	1.28	5.43
DER	3D	1.77	9.64
AUR	3E	2.83	13.58
SUR	3F	2.94	13.33
STH	40	5.44	9.77
LA	41	2.38	6.57
STC	42	5.30	8.43
IC	43	1.25	5.51
EX	44	.47	3.45
BAL	45	1.10	3.76
BCT	46	1.36	3.35
BC	47	1.72	3.95
LH	48	1.91	13.60
CH	49	2.46	13.71
AH	4A	2.28	14.35
SH	4B	2.28	14.33
MH	4C	2.13	5.17
CVD	4E	1.46	1.62
CVE	4F	1.47	2.79
ST	50	5.31	8.35
N	54	1.88	14.36
CL	55	1.87	8.68
O	56	1.91	14.88
X	57	1.88	15.33
L	58	1.90	7.65
C	59	1.88	8.68
A	5A	1.64	10.83
S	5B	1.63	11.36
M	5C	2.33	7.41
D	5D	1.01	5.68
AL	5E	1.65	9.19

OPERATION		168	158
SL	5F	1.63	9.19
STD	60	2.39	5.18
MXD	67	.80	9.66
LD	68	.77	3.79
CD	69	1.83	16.64
AD	6A	.87	11.57
SD	6B	.94	11.58
MD	6C	.80	4.74
DD	6D	.98	9.90
AW	6E	1.01	8.91
SW	6F	1.08	8.97
STE	70	5.54	10.59
LE	78	1.99	9.56
CE	79	3.25	22.22
AE	7A	2.83	16.72
SE	7B	2.81	15.84
ME	7C	1.38	6.24
DE	7D	1.77	9.77
AU	7E	3.10	16.94
SU	7F	3.05	16.01
BXH	86	1.31	5.10
BXLE	87	1.32	5.11
SRL	88	2.46	13.47
SLL	89	2.46	13.57
SRA	8A	2.42	16.03
SLA	8B	2.44	26.75
SRDL	8C	1.42	13.18
SLDL	8D	1.11	10.30
SRDA	8E	1.10	12.66
SLDA	8F	.91	16.26
STM	90	2.52	7.83
TM	91	1.91	11.53
MVI	92	5.04	7.82
TS	93	15.22	16.45
NI	94	3.41	5.39
CLI	95	1.91	8.67
OI	96	3.39	5.40
XI	97	3.41	5.44
LM	98	1.85	3.85

OPERATION		168	158
STCK	B2	1.54	2.38
MVN	D1	1.14	3.23
MVC	D2	2.71	8.02
MVZ	D3	1.14	3.23
NC	D4	1.14	3.23
CLC	D5	6.64	15.64
OC	D6	1.14	3.23
XC	D7	1.14	3.23
TR	DC	2.95	8.80
TRT	DD	3.67	10.71
ED	DE	4.10	16.91
EDMK	DF	3.98	15.61
MVO	F1	3.12	5.67
PACK	F2	3.10	4.88
UNPK	F3	2.43	5.13
ZAP	F8	3.58	9.35
CP	F9	3.55	10.07
AP	FA	3.79	11.37
SP	FB	4.29	12.76
MP	FC	4.67	9.59
DP	FD	3.61	10.00
MEAN GAIN		1.79*	7.00*

*The mean gain is not the mean of the ratios but is computed on the basis of a summation of instruction execution times for each machine compared to the 470V/6. This procedure gives additional weight to longer (or slower) instructions and was felt more indicative of overall internal performance.

APPENDIX III. COMPANY HIGHLIGHT

COMPANY HIGHLIGHT

AMDAHL CORPORATION
1250 East Arques
Sunnyvale, CA 94086
(408) 735-4011

Eugene R. White, President
Gene M. Amdahl, Chairman
Public corporation
Total employees: 645
Revenues, fiscal year end 12/76:
expected to be about \$90 million

KEY PRODUCTS AND SERVICES:

- Amdahl has designed and developed, and is manufacturing and maintaining, a large, high performance general purpose computer system. Called the Amdahl 470V/6, it is fully compatible with the IBM System 370/168. This compatibility allows Amdahl customers to utilize IBM software programs and IBM or IBM-compatible peripherals.
- The most significant feature of the 470V/6 is its extensive use of the company-developed large scale integration (LSI) Emitter Coupled Logic (ECL) circuitry for logic implementation. This component technology gives Amdahl a major advantage over IBM since IBM uses medium scale integration (MSI). This means that for every printed circuit board, IBM must use many MSI chips while Amdahl uses only one LSI chip.

OVERALL ASSESSMENT:

- Amdahl is aiming at the top of the line in IBM's mainframe business, and IBM will undoubtedly have to respond. Although IBM's response is unlikely to hurt Amdahl in the short run, in the long run IBM's \$1 billion R & D budget may allow IBM to enhance or change its systems more quickly than Amdahl can respond. By that time, however, Amdahl may be sufficiently entrenched in the mainframe market to be able to survive IBM's attack.
- Amdahl expects to continue expanding and updating its present system and to eventually introduce new architecture. Amdahl expects this will enable it to cope with IBM's new products.
- The Amdahl 470V/6 currently has a 1.7 to 2.0 price performance advantage over its IBM competitor.

COMPANY HIGHLIGHT/AMDAHL CORPORATION

FINANCE:

- The company's net profit in the last quarter was \$6.9 million on sales of \$26 million, or 27%. The management believes this ratio can be improved.
- The company has been shipping equipment over the last year and is currently shipping at a rate of \$100 million a year. To date, Amdahl has delivered 21 mainframes in the United States. By the end of fiscal year 1976, we expect it to ship 11 more mainframes, two of them overseas.
- Amdahl indicates that it can break even by shipping only one computer per month. It is possible for Amdahl to more than double its shipment of computers between 1976 and 1977.

INDUSTRY MARKETS:

- The company is dedicated to large users, because it believes these users have the largest investment in existing software and staffs capable and confident enough to take advantage of price performance improvements. The market the company has targeted encompasses 3500 installations and is estimated to be growing at 15% per year.
- Amdahl is currently serving the industrial, institutional, service bureau, and government industries.
 - It expects a significant portion of its future business to come from the U.S. Government.
 - Western Electric and Amdahl have negotiated a general agreement permitting Amdahl to ship up to 20 systems to Western Electric over the next 18 months.
 - Amdahl currently has 150 active proposals.
- To date, Amdahl systems have been sold or leased primarily through third parties. However, in 1977, the company expects to initiate its own four-year lease plan competitive with the IBM term plan. At that time, the company expects the ratio of sales to leases will be 70/30. Amdahl has technical, financial, manufacturing, marketing, and business relationships with Fujitsu Ltd. of Japan. Amdahl has exclusive marketing rights in the U.S. and Canada, while Fujitsu has exclusive marketing rights in Japan and Spain. The rest of the world is served by a 50/50 joint venture between Amdahl and Fujitsu.

COMPANY HIGHLIGHT/AMDAHL CORPORATION

COMPUTER HARDWARE AND SOFTWARE:

- The manufacturing responsibility at Amdahl is separated as follows:
 - The CPU and I/O channels are manufactured by Fujitsu.
 - The power distribution unit, the console, and the power supply are made by Amdahl.
 - The memory made by Fujitsu until recently will now be made by Amdahl.
- One of the major strengths of the company is its computer-aided design and testing capability. Amdahl assembles and final tests all its systems. The final systems test takes 4 weeks.
- Amdahl will start using 4K RAMS in the fourth quarter of 1976. Texas Instruments and National Semiconductor are the two qualified vendors.
- There are a total of 2200 LSI chips in the average Amdahl computer; there are a total of 111 types of chips in the Amdahl system. These chips are inserted in a multi-chip carrier consisting of a 10 layer printed circuit board which is used for both interconnection and support.
- Amdahl has 200,000 square feet of manufacturing space and expects to have a total of 260,000 by the first quarter of 1977.
- The Amdahl 470V/6 uses IBM software. IBM's system control programs are in the public domain, and they must be provided to everyone for a service fee. The program products (applications programs) must also be provided to everyone for a fee.

APPENDIX IV. AMDAHL QUESTIONNAIRE

INPUT

AMDAHL USER QUESTIONNAIRE

SYSTEM CONFIGURATION

1. _____ Replacement _____ Addition

Previous

Present

2. System mfg. and model

Memory size K K

No. of channels

Type of peripherals

Disk IBM Other

Tape IBM Other

Printers IBM Other

RJE IBM Other

Terminals IBM Other

Operating System

3. Other computers in installation ? _____ No _____ Yes

Manufacturer	Model	Core Size
		K
		K
		K
		K

4. Is system connected to a Network ? _____ Yes _____ No
Other Processor ? _____ Yes _____ No

5. Do you have plans to expand:
Memory ? _____

Channels? _____

Front-end processor ? _____

Mass memory? _____

6. Will you use plug compatible peripherals ? _____ Yes _____ No
Any plans? Vendors? _____

MAINTENANCE

7. Who did maintenance on previous equipment? _____

8. Current maintenance? _____

9. Would you use multi-service maintenance vendors? _____ Yes _____ No

DECISION PROCESS

10. How many people involved in the study? _____
Titles? _____

11. How many involved in the decision? _____
Titles? _____

12. Was decision unanimous? _____ Yes _____ No

13. What negative opinions were held about AMDAHL?
Financial? _____

Technical? _____

Other? _____

14. How long do you plan to keep the new system ? _____ years

15. Have you any concern that your present commitment will prevent you from taking advantage of future systems improvements?

Hardware? _____

Software? _____

16. Did you have strong positive reasons for your decision?

17. How long did your study take? _____

18. How long between study and decision? _____

19. What type of analysis was performed?

Type	Results

20. Benchmark applications?

Type	Results

21. Financial and price/performance? _____

SATISFACTION RATING

22. Is the system performing to your expectations? (Downtime, throughput, etc.?) _____

23. Was the conversion smooth? _____

24. What do you most like about the new system? _____

MARKETING

25. What did competition do to keep or capture the account?

26. What were the strong points of marketing and marketing support personnel? (Technical skills, understanding of user, economic analysis, etc.) _____

